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EDITED BY

R. S. SHAW AND E. B. HILL

CONTRIBUTIONS BY ALL SECTIONS OF THE EXPERIMENT STATION

MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY
AUGUST, 1924

FINISHING BABY BEEF

Calves Fed at M. A. C. during the Winter of 1923-24

G. A. BROWN AND G. A. BRANAMAN, ANIMAL HUSBANDRY SECTION

One of the methods of beef production that is becoming very popular in some sections of Michigan is the growing and "feeding-out" of calves for baby beef, putting them on the market at 12 to 18 months of age, at a weight of 800 to 1,000 pounds. Not only in Michigan is this system followed quite extensively, but in all States of the corn belt. In fact, the demand for feeding calves has become so great that a great many Western rangemen are selling their calf crops, when taken from the cow, direct to the corn belt feeders.

Requests for data on the most profitable ration to feed these baby beef calves led the Michigan Agricultural Experiment Station to begin a series of experiments in the fall of 1923 to determine some of the factors to be considered in choosing a ration for these calves.

Fig. 1. Steers of Lot I as they appeared when finished. This picture shows the type of steers used in this experiment.

Texas Calves Purchased

An entire calf crop of 140 head of high grade Texas Hereford calves had been shipped into Michigan in October, and since they were a very uniform lot of calves raised in the same herd, 30 head of the choice steer calves were selected for the experiment.

They arrived at the College November 8 and were carried on a ration of silage and alfalfa until started on experimental feed December 8, at which time they weighed an average of 463 pounds, and cost $8.90 per hundred pounds in the lots.

They were divided into three lots as near uniform as possible in regard to size, form, condition, and quality.

Rations Fed

The basal ration of silage and alfalfa was continued in all lots throughout the experiment. Each lot received all the silage they would clean up readily, twice per day, and alfalfa hay was kept before them in racks.

A mixture of equal parts by weights of shell corn and whole oats was fed all lots the first 60 days, three parts corn and one part oats the next 60 days, and corn alone the last 70 days. The calves in Lot 1 and Lot 2 each received, in addition, one pound of oilmeal per day the first 120 days, one and one-half pounds per day the next 30 days and two pounds per day the last 40 days, fed on the silage night and morning.

Lot 1 was put on a self feeder of grain at the end of 30 days, when by gradual increase they had reached a full feed. Lot 2 was hand fed twice daily approximately two-thirds the amount of grain consumed by Lot 1 throughout the experiment. Lot 3 received no oilmeal, but was fed an amount of grain equal to the total weight of the grain and oilmeal fed in Lot 2.

Water in tubs was kept before the calves at all times, and a mixture of salt, bone flour, and sulphur was supplied. They were housed in a shed with doors opening to the east into small, cinder-bottom lots. These doors were open except on the very coldest nights.

Gains by Pigs is Small

There were four pigs in Lot 1 and two in each of the other lots. These pigs were fed shelled corn and tankage at night, as much as they cleaned up readily. There would have been just about enough feed in the droppings in Lot 1 for two pigs, judging from the amount of extra feed supplied. One pig in the other lots would have hardly handled the feed available.

Feed Consumption Varied

A study of the table shows that Lot 1 consumed a relatively larger amount of grain as compared with the other two lots, and consequently smaller amounts of silage and alfalfa. Lot 2 consumed considerable more silage and slightly less alfalfa than did Lot 3. A comparison of total dry matter in the average daily ration shows Lot 1 to have received 19.2 pounds total dry matter per day per calf, Lot 2,—17.1 pounds dry matter, and Lot 3,—16.1 pound dry matter, or a difference of 2 pounds between Lots 1 and 2, and 1 pound between Lots 2 and 3.

Table 1.—Summary of results.

10 Calves per lot 190 days Dec. 8, 1923—June 15, 1924.

	Lot 1	Lot 2	Lot 3
Initial cost in lots	$8 90	$8 90	$8 90
Initial weight per calf	462.5 Lbs.	464 8 Lbs.	462.1 Lbs.
Final weight per calf	966 2 Lbs.	951.2 Lbs.	905 2 Lbs.
Average Daily gain	2.65 Lbs.	2.56 Lbs.	2.33 Lbs.
Average daily ration:			
Corn	10.21 Lbs.	6.34 Lbs.	7.36 Lbs.
Oats (fed 120 days)	2.65 Lbs.	1 59 Lbs.	1.82 Lbs.
Oilmeal	1.24 Lbs.	1.24 Lbs.	....
Silage	7.34 Lbs.	16 70 Lbs.	11 46 Lbs.
Alfalfa	3.32 Lbs.	4.97 Lbs.	5 36 Lbs.
*Cost per cwt. gain	$10 23	$9 38	$9 20
*Cost per cwt. gain (deducting pork)	9 92	9 15	8 92
*Necessary selling price (deducting pork)	9 43	9 03	8 91
Dressing percentage	61.18%	60 12%	59 69%
**Selling price in lots	$9 70	$9 20	$9 20
*Profit per steer (not considering pork)	99	53	1 36
*Profit per steer (pork included)	2 57	1 63	2 63
***Cost per cwt. gain (deducting pork)	9 28	8 05	7 75
***Profit per steer (pork included)	5 79	7 00	7 80

*Corn 80 cents per bu., oats 48 cents per bu., oilmeal $55.00 per ton, Silage $5.00 per ton, Alfalfa $20.00 per ton, pork $7.00 per cwt.
**Selling price in lots is Detroit price less 85 cents.
***Silage $4.00 per ton, alfalfa $12.00 per ton, other feeds the same as above.

Gains Correspond to Feed

A glance at the average daily gains shows the same general relationship between the gains in the different lots as was shown in the feed consumed. Lot 1 gained on the average 2.65 pounds, Lot 2,—2.56 pounds, and Lot 3,—2.33 pounds per day. However, there is less difference between the gains in Lots 1 and 2 than between those in Lots 2 and 3.

The pork produced is practically in proportion to the grain fed, so that the difference in cost of gains between the lots is not materially influenced by the pork produced. The cost of gains, deducting pork, show those in Lot 2 to be 77 cents cheaper than those in Lot 1, and those in Lot 3 exactly $1.00 per cwt. cheaper than in Lot 1.

The necessary selling price in the lots to break even, pork considered, is $9.43 in Lot 1, $9.03 in Lot 2, and $8.91 in Lot 3, a difference of 40 cents between Lots 1 and 2, and only 12 cents between Lots 2 and 3. In other words, in order to pay market price for the feed as charged in the table, Lot 2 must sell for 12 cents more per cwt. than Lot 3, and Lot 1 must sell for 52 cents more than Lot 3.

All Lots Topped Detroit Market

Livestock commission men from Detroit valued the calves as they stood in the lots at the close of the experiment as follows: Lot 1—$10.50, Lot 2—$9.75, Lot 3—$9.50, Detroit prices. They thought the calves in Lots 2 and 3 were not so fat and showed considerably more middles than those in Lot 1. There was little difference between Lots 2 and 3.

As they showed on the market at Detroit, Lots 2 and 3 did not show the full middles they did in the feed lots. Therefore, they considered Lots 2 and 3 as being equally good, and Lot 1 only 50 cents per cwt. better

The entire drove sold at $10.25 straight, which was $1.25 above top quotations. The shrink and shipping expense amounted to 85 cents per hundred pounds, which was deducted from the Detroit price to get the price in the lots.

Each Lot Profitable

All lots show a profit not considering pork; Lot 1 a profit of 99 cents per head, Lot 2,—53 cents per head, and Lot 3,—$1.36 per head. Considering pork produced, Lots 1 and 3 show practically the same profit per steer, $2.57 and $2.63, and Lot 2 $1.63 or one dollar per steer less.

When silage and alfalfa are charged at a lower price, as would be true for some sections in which calves are fed, Lot 1 shows less profit than either of the other lots, and Lot 3 still shows a better profit than Lot 2, as given at the bottom of Table 1.

Either of these three rations would be considered a very good ration by many calf feeders, and a continuation of the experiment will be necessary, giving several years' results with different lots of calves before positive conclusions can be drawn.

HOGGING OFF CORN

At Feeding Trial which Emphasizes the Importance of Feeding a Supplement High in Protein Content to Hogs Running in the Corn Field

G. A. BROWN AND W. E. J. EDWARDS, ANIMAL HUSBANDRY SECTION

An experiment has been started with three one-acre lots of corn to determine the price received for corn hogged off and the value of different supplementary feeds in hogging off corn. The plan has been to have rape sown in one acre, at the time of the last cultivation and use no other supplement; soy beans planted with the second acre at the time the corn was planted, and a third acre of corn with tankage fed in a self-feeder.

Owing to unfavorable weather conditions last year, the rape did not grow; neither did the soy beans. To Lot 1, therefore, oats were fed in a self-feeder; to Lot II, ground soy beans were fed in a self-feeder, and to Lot III, tankage in a self-feeder, the results being as follows:

Table 1.—Showing results of hogging off corn and the use of supplementary feeds.

	Lot I Whole oats in self-feeder	Lot II Soy beans in self-feeder	Lot III Tankage in self-feeder
Average initial weight	111.37	110.5	112.5
Average weight at end of 33 days	152.63	149.13	171.63
Average daily gain	1.25	1.17	1.792
Supplementary feed eaten per pig per day	.648	.413	.265
Value of pork produced at $7.00 per cwt	$23 10	$21 49	$33.11
Value of supplementary feed eaten	2 56	1 63	2 10
Value of gains produced by corn	20 54	19 86	31 01
Yield of corn	27.75 (bu.)	28.14 (bu.)	34.82
Price returned by hogs for each bushel of corn	$ .7401	$ .705	$ .89
Corn used to produce 100 lbs. of pork	470.9 (lbs.)	513 (lbs.)	412
Supplement used per 100 lbs. of pork	51.82 (lbs.)	35.28 (lbs.)	14.8

Conclusion

The yield of corn was obtained by husking out two rows from each acre. This was later fed back to the pigs. The moisture content of this corn was determined and the above yields are based upon No. 2 corn containing 15½ per cent moisture.

All lots were fed a mineral mixture in a self-feeder. The oats and soy beans were charged to the pigs at 1½ cents per pound and the tankage at 3 cents per pound. The above trials emphasize the importance of feeding a supplement high in protein content to hogs running in the corn field. In this trial the pigs paid for the tankage at $3.00 per hundred and then returned a higher price per bushel for corn than either of the other two lots.

YEAST FOR FATTENING SWINE

A Ninety Day Feeding Trial to Determine the Value of this Product as a Pig Feed

G. A. BROWN AND W. E. J. EDWARDS, ANIMAL HUSBANDRY SECTION

Owing to the wide publicity given yeast as a feed for swine and the many testimonials which have appeared, claiming wonderful results from the use of yeast, it was deemed advisable to conduct the following trials.

All lots received the same grain ration, consisting of 100 pounds of corn meal and 12 pounds of tankage the first 30 days, 100 pounds of corn meal and 9½ pounds of tankage the second 30 days, 100 pounds of corn meal and 8 pounds of tankage the third 30 days. Yeast was fed as directed by the manufacturers. The ration for Lot VI was mixed as a slop, one-fourth of one per cent of yeast added, and the feed allowed to ferment forty-eight hours before feeding. Lot VII was fed a slop with one-half of one per cent of yeast added just before feeding. Lot VIII was a check lot, being fed the same as Lots VI and VII except that they received no yeast.

Table 1.—Results of the trial, indicating little or no benefit was secured by feeding yeast

	Lot VI Yeast fermented feed	Lot VII Yeast added just before feeding	Lot VIII Check lot
Average initial weight	88.	88.5	89.7
Average weight at end of 90 days	237	226.75	239.5
Average daily gain	1.656	1.536	1.664
Feed for 100 lbs. gain:			
Corn meal	327	357.7	326.4
Tankage	31.8	33.8	31.0
Yeast	1.2	1.9	....
Total feed for 100 lbs. gain	360	393.4	357.4
Returns per bushel of corn with hogs selling at $7.00 per owt. and tankage costing $3.00 per owt.	$1.0392	$ .9363	$1.04

Conclusion

The returns per bushel of corn are the entire receipts from the hogs less only the cost of the tankage. Housing, labor, equipment, interest, etc., not being considered. Neither was the yeast charged, as it was donated for experimental purposes. Had the yeast been charged against the pigs at retail prices, Lots VI and VII would have returned a much lower price per bushel for corn than Lot VIII which received no yeast.

It could not be observed that the addition of yeast forty-eight hours in advance of feeding and the fermentation of the feed, had any effect whatever upon the rate of gain, the appetite of the pigs, or the amount of feed consumed per pound of gain, as this lot compared very closely with the lot receiving no yeast.

Lot VII, to whose feed yeast was added just before feeding, did not make quite as large daily gains and consumed somewhat more feed per pound of gain than either of the other two lots. As there were only four pigs in each lot, the increased amount of feed required by this lot may possibly have been due to variation in the pigs.

POULTRY CULLING IS PROFITABLE

Systematic and Intelligent Culling Enables the Owner to Eliminate Unprofitable Birds

E. C. FOREMAN, POULTRY SECTION

The culling of poultry is now recognized as a sound economic practice. Productiveness or egg laying ability is determined by definite physical characters, directly associated with egg production.

In the ordinary farm or commercial poultry flock that has not been carefully line-bred over a period of years, will be found hens that vary widely in inherited characteristics. Such flocks can be accurately classified and grouped according to degrees of productiveness.

The factors causing a variation of physical characters can be roughly classified into two groups, including the genetic and the physiological or environmental. The genetic factors, those characteristics that come to the individual as a result of inheritance, place a limitation on the productiveness of the individual. High and low egg line families or strains reveal a wide contrast in type, conformation and nervous organization which in turn is reflected in both the efficiency and distribution of egg production.

Environmental factors causing individual variations frequently occur in the pre-production or growing period. Pullets of identical breeding may vary greatly in physical development and sexual maturity if hatched during different months and placed under different condition of feeding and management.

In the culling of poultry, however, we are primarily interested in the

physiological changes that result directly from the rate and distribution of egg production. While climatic conditions, time of hatching, rate of maturity, method of feeding, artificial illumination, housing and personal factors influence flock production, the responsiveness of each individual hen is so variable that culling can be accurately accomplished by a few careful observations.

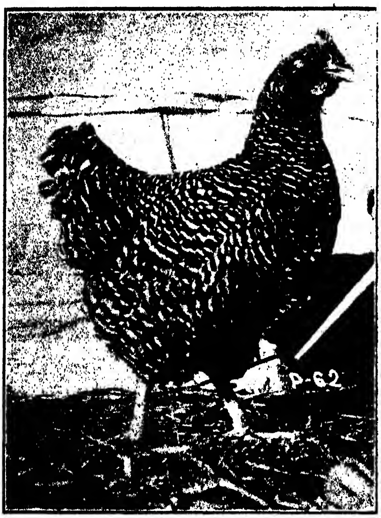

Fig. 2. 250 Egg, Barred Plymouth Rock. Note aggressive disposition, intelligent and expressive face characteristic of a high nervous organization and profitable layer.

Fig. 3. 300 Egg, White Leghorn. A well-balanced individual combining unusual laying temperament with a large substantial body capable of withstanding the strain of heavy production.

Pigmentation Change

A yellow pigment associated with the storage of fat, is present in the cells in various sections of the body in all yellow skin breeds. This pigment, sometimes referred to as xanthophyll, is reabsorbed and provides the coloring matter for the egg yolk fat. By noting the pigmentation changes that occur, as production progresses, the past history of the inindividual becomes an open book, and the profitableness of the individual quickly determined.

The pigment always leaves the different sections of the body in very definite order, following in each case the channels of most rapid blood circulation. The inner margin of the vent releases this pigment first, occuring after the hen has been in production for about one week. The yellow ring around the outer edge of the eye lid disappears next, and is followed by a loss of pigment in the ear lobes.

This yellow coloring matter then leaves the inner margin of the beak, gradually working outward and is last evident near the tip of the upper

mandible. It usually requires from four to six weeks of regular production before a total loss of pigment is evidenced in this section. The shanks are the last section to lose this coloring matter, which under normal conditions will disappear after the hen has been laying consistently for from four to six months. The pigment disappears from the front of the shank first, and is last evident in the heel and on the scales of the toes.

Hens that reveal a highly colored shank at this season of the year, have not as a rule, produced profitably, and their production is in nearly every case, restricted to the spring months, the natural reproductive season when eggs have their lowest value. On the other hand, the hens that have given a generous distribution of production throughout the winter months will show a bleached condition of all sections at this time, and if they are in good health should be retained.

Abdominal Capacity

Poultrymen commonly make the mistake of over emphasizing the relative importance of abdominal capacity, in determining individual production. Abdominal capacity does, however, indicate "laying condition" and furnishes a satisfactory method of measuring the immediate rate of production.

Ordinarily a hen that is laying from five to seven eggs per week will have a full, soft, pliable abdomen. A greatly expanded condition will be found in the abdominal and pelvic region. The functioning ovary and oviduct increases in size about twenty times and in addition, the heavier food consumption that becomes necessary through the demands of production causes this enlarged abdominal condition. A spread of from four to six fingers will usually be found between the keel or breast bone and the end of the pelvic arch or pubic bones. Moreover, the two pubic bones spread and become more pliable. The vent also becomes greatly dilated, oval in shape and moist.

The opposite conditions are present in hens that have been off production for some time. The abdominal and pelvic regions, are contracted, and usually hard, indicating a lack of quality.

The intermediate condition found in hens coming into production, or which are broody or temporarily off production is revealed by an absence of fullness in the abdominal region, although a flexible and expanded condition of the pelvic and abdominal region is evident.

Moulting

The classification of hens according to productiveness by the rate and time of moulting, is based entirely on the fact that heavy layers distribute their production over a period of from ten to twelve months.

Those hens, therefore, that cease laying in August or earlier, as a rule, are unprofitable stock. Many poultrymen have labored under the delusion that the early moulter would be a profitable winter layer, because of the fact she would complete the moult before cold weather arrived. Trap nest records reveal the fact that early and slow moulters are the most unresponsive individuals, lacking this genetic factor that stimulates a high winter production.

The greatest accuracy is obtained in culling hens by the moulting test, when the rate of moult is considered. Occasionally profitable layers will moult the latter part of August, especially if a change of ration is made during the summer months. Such hens will, however, reveal a well bleached condition of the shanks and the moulting period will be limited to from six to eight weeks. The hen carrying a high density or deep yellow pigment in the shank and moults both early and slowly, is a typical cull.

The ideal laying and breeding type reveals a rough, soiled and broken condition of plumage at this season, and is a generous producer until the latter part of October or early November. She makes moulting a business, and reduces the time lost during this period to a minimum. At one stage of the moult she resembles a pin cushion, due to the sudden loss of the old plumage and the return of a new crop of feathers. A high, second-year record can be expected from such individuals, and they usually prove to be more satisfactory breeders than either the extremely early or late moulting types.

Intensity Factors

An analysis of the trap nest record of a two hundred egg hen reveals the fact that a hen must show a high monthly intensity in addition to spreading her production over nine or ten months of the year. By intensity of production, we mean the number of hours it requires a hen to manufacture an egg or the number of eggs she is capable of producing during a single month.

This intensity factor is largely measured by the conformation and nervous organization of the individual. The contrast between high line and low line stock is obvious. The egg type conformation and nervous

Fig. 4. Anatomical variation in high and low producer. A deep body (left) is usually associated with high production and a shallow round body (right) with low production.

organization is similar to the highest production dairy type. A cross section of a heavy laying hen should resemble a triangle. This calls for a long, deep, flat rib, broad flat back that holds its width, and a long well arched keel.

The head should be of medium length and depth with strong impressive lines. The eye should be bright, prominent and expressive. The skull should be moderately wide and flat on top, gradually widening from the juncture of the beak to a point directly back of the eyes. The skin lining the face reflects to a large extent, quality of fleshing. It should give the face a smooth, lean appearance, with an absence of all tendencies towards wrinkling or coarseness.

The neck should be neatly attached, avoiding all indications of throatiness. The beefy, masculine or crow headed types of hens decidedly lacking in character seldom make satisfactory breeders or layers.

The nervous organization of the hen is one of the most important factors that can be used in a study of laying temperament. The high laying hen is usually aggressive, friendly and talkative. The extremely nervous, flighty and squaking individuals or hens showing an entire absence of this keen ambitious disposition, seldom respond to the best feeding practices and should be culled at this season of the year.

Advantages of Culling

Systematic and intelligent culling releases a large quantity of feed for more productive purposes. It enables the owner of the poultry flock to place the unprofitable birds on the market to best advantage. It increases the efficiency of the remaining hens, as an increase in production, after the cull hens have been removed frequently occurs. Less labor is required for the care of flocks that are regularly culled and the earning capacity of the individual or flock is greatly increased.

While culling is a sound economic practice that should be adopted by every progressive poultryman, advantage should be taken of the possibilities, latent in every flock, by the segregation, during the breeding season, of the outstanding layers, so that fewer culls will be produced each year and a strain could be developed with definite characteristics, all of which are associated with high and efficient production.

FEEDING CULL BEANS TO DAIRY COWS

A Report of the Second Trial of Experiments with Cull Beans

O. E. REED AND J. E. BURNETT, DAIRY SECTION

During the winter of 1923-1924 a second trial of feeding cull beans to dairy cows was conducted in completion of work previously reported (Mich. Expt. Station Quarterly, Vol 6, No. 2, p. 43).

The method of conducting this trial was the same as in the first trial. Twelve cows from the dairy herd were divided into two lots of six cows

each. Care was taken in the selection to choose cows so that the two lots would be as nearly balanced against one another as possible as to time in lactation, date of breeding, etc.

As before, the two lots were fed rations containing cottonseed meal or ground cull beans by the reversal method. Thus Lot 1 was fed the ration containing ground cull beans for thirty days. They were then given the ration containing cottonseed meal for a thirty day period. This was followed by a final thirty day period on the ration containing ground, cull beans. In the same manner, Lot 2 was first fed the cottonseed ration for thirty days, then the bean ration for thirty days and finally the cottonseed ration for thirty days. In each case, the first ten days of the feeding period was considered as a preliminary feeding period in which to get the cows on feed and this ten day period was not considered in computing the results. The cows were weighed daily and their milk was weighed at each milking and tested daily.

Rations

Results of the trial made in 1922-23 on feeding cull beans to dairy cows convinced the writers that success in feeding cull beans to dairy cows necessitated their use in a grain mixture that was highly palatable. Consequently, before the second trial was started several rations were prepared and fed to cows and the apparent palatability of the mixtures noted. From this work the rations below were developed which seemed to possess palatability and yet contain a reasonable percentage of the ground cull beans. Since alfalfa hay and silage were fed, a ration relatively low in protein was indicated. The palatability of this ration is indicated by the fact that very little grain was left during the preliminary feeding periods and that no cow at any time left her grain during the twenty day periods used for comparison.

Bean Ration	Cottonseed Ration
40 lbs ground corn	40 lbs. ground corn
40 lbs. ground oats	40 lbs. ground oats
25 lbs. ground cull beans	12½ lbs. cottonseed meal, 37%
10 lbs linseed oil meal	10 lbs. linseed oil meal
1 pound of above contains—	1 pound of above contains—
.125 lbs. digestible protein	.141 lbs. digestible protein
.772 lbs. total digestible nutrients	.780 lbs. total digestible nutrients

The grain ration was unchanged throughout the trial. Somewhat more than the amount of nutrients required, as indicated by Henry and Morrison's standard and by the slight gain in flesh of the cows, was fed. The cows were given fifteen pounds of good quality alfalfa hay and thirty or thirty-five pounds of silage daily. The amount of hay and silage fed in the trial remained unchanged throughout the periods. The cows ate all the hay and silage offered to them.

The method used in computing the results varied somewhat from that used in reporting the first trial. The weights of the cows given below in Table I indicate the gains made by the groups during the twenty day feeding period. In obtaining these figures the average weights of the first five and the last five days of the feeding periods were used.

Table 1.—Results of the second trial, indicating that cull beans are very nearly if not entirely as efficient for milk production as one-half as much cottonseed meal.

Lot I	Milk	Butter fat	Weight gain for period
1. Bean ration	3,472.0	126.355	93
2. Cottonseed ration	3,275.9	116.197	76
3. Bean ration	3,054.3	104.274	39
Average 1st and 3rd periods, bean ration	3,263.2	115.315	66
2nd period, cottonseed meal ration	3,275.9	116.197	76
Difference in favor of cottonseed ration	12.7	.882	10
Lot II			
1. Cottonseed ration	3,305.0	133.698	101
2. Bean ration	2,991.0	123.238	3
3. Cottonseed ration	2,823.8	113.279	24
Average 1st and 3rd periods, cottonseed ration	3,064.4	123.489	62
2nd period, bean ration	2,991.0	123.238	3
Difference in favor of cottonseed ration	73.4	.251	59

The results of this trial indicate that cull beans are very nearly if not entirely as efficient for milk production in the dairy ration as one-half as much cottonseed meal. The slightly larger amounts of milk and butter-fat produced on the cottonseed ration are not indicative of a more efficient ration as they are so small as to come within the range of probable experimental error. There is, however, somewhat more evidence of such superiority in the increase of weights which averaged higher with the cottonseed ration than with the bean ration.

It is the belief of the writers that a comparison of these two trials indicates rather clearly that in cull beans we have a home-grown, protein feed which usually has a low sales value, but which has a feeding value for dairy cows of nearly half that of cottonseed meal. It is further indicated that the feeding value of cull beans is dependent to a large extent upon the palatability of the other feeds in the grain ration.

MINERAL FEEDING INVESTIGATIONS

In Some Sections the Problem of Supplying Minerals to Livestock is an Important One

BY O. E. REED AND C. F. HUFFMAN, DAIRY SECTION

During the past few years, there has been an increasing interest in the subject of feeding minerals to live stock. At the present time there is quite a demand for information along this line from live stock men. It is a well recognized fact that animals need minerals in sufficient quantity and variety in the ration to furnish the necessary elements for skeleton

growth, milk production, and for the proper functioning of the entire body.

It is just as important to see that minerals are present in the ration, as it is to balance it for protein, carbohydrates, and fat. As long as animals have access to feeds containing the various minerals, this condition does not need much attention, but when our soil becomes worn out, we often find that there is a deficiency in the plant products of one or more of the essential mineral elements. This soil deficiency is first shown, not so much by the relative effect upon the plant itself as by the kind of crop which can be grown successfully. Such crops as the legumes, clover, alfalfa, etc., which are the most potent source of minerals for live stock, cannot be grown on many soils at the present time although these same soils formerly grew these crops quite successfully.. Wherever such crops cannot be grown, the problem of supplying minerals to live stock becomes an important one.

At the present time the Dairy Section of the Michigan Experiment Station is conducting a number of experiments to determine the best sources of mineral supplements and their importance in various rations commonly fed on Michigan farms.

Thirty heifers are being used in an experiment to obtain information on this subject. These heifers are divided into six lots that are being fed as follows:

Lot I. A basal grain ration, silage and timothy hay—no mineral supplement.

Lot II. A basal grain ration, silage and alfalfa. Source of minerals—alfalfa hay.

Lot III. A basal grain ration, silage, timothy hay, and a complete mineral mixture.

Lot IV. A basal grain ration, silage, timothy hay, and bone meal.

Lot V. A basal grain ration, silage, timothy hay, and a mineral mixture containing equal parts of finely ground limestone rock and raw rock phosphate.

Lot VI. A basal grain ration, silage, timothy hay, and pasture in season. No mineral supplement.

As shown in the above rations one object is to determine the value of mineral supplements from various sources and their effect on health, growth, reproduction, and milk production. Another object is to compare alfalfa hay with timothy hay as a source of minerals and also to determine just how far it is possible to make good the apparent mineral deficiency of timothy in comparison with alfalfa.

Lots I to V inclusive will be kept in a dry lot during the entire experiment, while Lot VI will be turned on pasture each year for the entire grazing season.

Importance of Lime

The mineral most likely to be lacking in the ration of dairy animals is lime. The grains and many of the roughages other than the legumes are deficient in this element.

In order to determine the symptoms of lime deficiency in dairy cattle, six heifers are on an experiment in which the ration is extremely low in lime, but adequate in every other respect. The effect of such a ration on health, growth, and reproduction will be observed.

Factors Carried by Roughage

The dairy cow has probably been taken farther from the natural way of living than any other class of live stock. She is now fed a ration consisting largely of concentrates, while in her natural state her food was almost entirely roughage. The effect of such a change in feeding on the dairy cow is not known. However, many of the ailments of the modern dairy cow may be due to the greater consumption of grain in proportion to hay.

Our results indicate that the alkaline reserve of the blood of dairy cattle is influenced by grain feeding. Herds receiving roughage alone had a higher alkaline reserve than did herds which received considerable grain.

Calves receiving milk or grain alone, die with the symptoms of toxaemia, but where hay is fed along with milk or concentrates the calves do well. To determine the factors carried by hay which prevent the calves from becoming poisoned, several animals are being fed rations free from roughage, but containing different mineral and vitamin combinations. The addition of either calcium carbonate, bone meal, raw rock phosphate, tricalcium phosphate, magnesium phosphate, wood ashes, or a mineral mixture similar to the minerals found in alfalfa, to the ration fed to calves showing the symptoms of toxaemia, relieves the condition and prolongs the lives of the animals many months.

Depraved Appetites in Calves

Calves often develop a depraved appetite resulting in the swallowing of material which cannot properly be described as food. Depraved appetite occurs more often in calves and is manifested by eating dirt, cribbing (gnawing wood, leather, bones, etc.) and also by licking each other, where the calves are penned together, or where isolated, by licking themselves. Depraved appetite in calves occurs under varied conditions of nutrition and results in stunted growth, unthrifty appearance, and quite often in death. The Dairy Section in co-operation with the Chemistry Section of the Experiment Station is attempting to work out the cause of and the cure for depraved appetite in calves. The work thus far indicates that mineral feeding is not a definite cure for this condition.

MARL DIGGING DEMONSTRATIONS

Methods of Digging Marl with Low Cost Equipment are Being Shown in Areas Where Marl Deposits are Common

H. H. MUSSELMAN, AGRICULTURAL ENGINEERING SECTION

Nineteen demonstrations of digging marl are being undertaken by the Agricultural Engineering Extension Service of the College for this summer. These demonstrations cover the principal areas of the State where marl is found in abundant quantities.

It is expected that in the work of carrying out these demonstrations, that considerable data on the handling of marl under extremely variable conditions will be accumulated and summarized at a later date.

These demonstrations are the outcome of the recent development of low cost equipment for handling marl by the Michigan Agricultural Experiment Station. The Agricultural Engineering Section has developed a one-fifth yard bucket operating with a comparatively small unit of power and on a new principle which makes it possible to dig marl of almost any consistency from lakes and marshes.

A great many of the deposits of marl are found in lakes and marshes where the marl is over-laid with water. Any method of digging marl must therefore work under these conditions. The fact that the marl is over-laid with water has made it extremely difficult for the farmer to secure marl for use, with the ordinary equipment and means at hand.

Fig. 5. Marl taken from a lake by equipment designed for that purpose.

The bucket developed by the Agricultural Engineering Section depends for loading, upon the principle of slicing off a thin layer of marl which is allowed to fill the bucket. By the adoption of this plan a large amount of power is not necessary in loading the bucket. The principle of unloading the bucket consists in having a flexible belt which lines the bottom and back of the bucket. The belting is pulled forward at the unloading point and discharges the marl by rolling it out of the bucket. A special type of hoist has also been developed by the station for operating this bucket.

The total cost of the outfit developed by the Agricultural Engineering Department is estimated at from $250 to $350, depending somewhat upon the way it is made up. Approximately one-third of this cost is in the cables and pulleys, one-third in the cost of the bucket, and about one-third in the hoist.

The work of the bucket thus far has shown a capacity of approximately 50 yards a day. It is estimated that with this type of outfit, taking into account depreciation, interest, and fuel and labor costs, that marl can be delivered on solid ground at a cost of approximately 50c per yard.

In the demonstrations is also shown another bucket developed by a farmer, William Phelan, of Kalamazoo, Michigan. This bucket is of somewhat larger capacity than the one developed by the College and is operated by a special hoist attached to the front of a small tractor. This type of outfit being somewhat larger is shown primarily as a contractor's type of outfit. It should, however, be practical for small installations.

In the development of the use of marl, it is felt that the cost of equipment should be low enough to be made profitable when used by a single farmer or a small group of farmers. In the above estimates of costs it is assumed that it is necessary to remove not more than 500 yards of marl

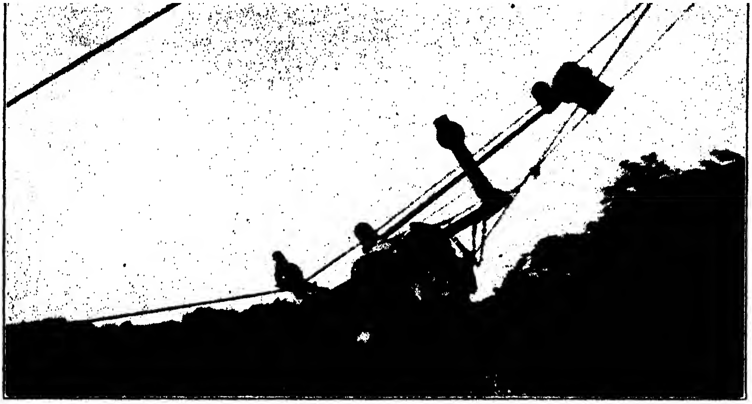

Fig. 6. The bucket is being unloaded by the action of the flexible belt lining of the bucket which is pulled forward when the push rod strikes the stop block on the track cable. Bucket designed by the Agricultural Engineering Section of the Michigan station.

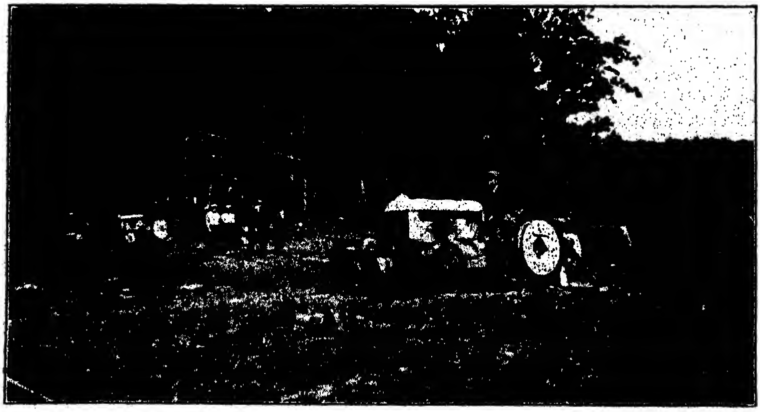

Fig. 7. The small tractor may be equipped with comparatively low cost attachments for operating marl digging equipment.

per year in any location to make it possible to handle it at the cost of 50c per yard. Small installations of this kind should make it possible for the farmer in the community where marl deposits are found to make thorough trials of marl and determine for himself its value as a liming agent for the soil.

Fig. 8. A special hoist adapted to drive by belt from the small tractor. This type of hoist may be used for operating marl digging equipment.

The interest shown in these demonstrations indicates that the farmers of the state in the sections where marl is found are alive to the possibilities of this material as a liming agent for their soils. The use of marl and other liming materials are making possible the successful culture of alfalfa and other legumes in sections where the soil is in a sour or acid condition. Thus, the Marl Digging Demonstrations go hand in hand with the Dairy-Alfalfa Campaign which is making alfalfa one of the leading legumes in the state.

Those interested in the digging and handling of marl should correspond with the Agricultural Engineering Department, Experiment Station, East Lansing, Mich.

Simple Water Systems

A new bulletin of special interest to the housewife has just been published by this Station. It is Circular Bulletin No. 64, entitled "Simple Water Systems," and is by O. E. Rabey of the Agricultural Engineering Section. This publication describes in detail the various types of simple water systems which may be installed in any farm home.

Systems are described which provide for hot and cold water, for a bathroom, and for running water. These systems may be installed and operated in homes without furnace heat. Copies of this bulletin may be secured free upon request to R. S. Shaw, Director, East Lansing, Michigan.

THE ELM LEAF BEETLE

Michigan has just Acquired a New Pest which was Recently Found in the Southwestern Section of the State

R. H. PETTIT, ENTOMOLOGY SECTION

Every little while our United States is invaded by some new pest which comes in from abroad and which establishes itself in this country far from the natural enemies which hold it in check in its native home. It is quite natural that the cities on the sea coast should acquire these undesirable aliens first of all, and it is just as natural that they should spread from the seaboard inward, until finally other portions of the country, suiting the requirements of the insects, should be invaded.

Michigan has just acquired a new pest. The elm leaf-beetle has established itself in the pretty little city of Monroe and started in its regular program of injuring the elm trees used for shade along the streets. This creature arrived in the United States about 1834, as near as we can tell, and has gradually spread over the eastern United States as far south as North Carolina and west to Kentucky. A number of years ago Ohio was invaded and we have been watching for it to appear in Michigan for the last eight or ten years. Now that it is here, it behooves us to get busy and make a search for the pest all over southeastern Michigan.

The elm leaf-beetle goes through the winter hidden away under leaves and rubbish and under loose bark flakes of trees and in any other sheltered places, sometimes in dwellings and barns. When the growth starts in the spring, the beetle attacks the young leaves and eats the fresh new growth with much relish. Along in June the beetles lay their eggs in clusters on the leaves. The eggs are yellow in color and are deposited in rows on the under surfaces of the leaves. In a few days these eggs hatch

Fig. 9. The Elm Leaf Beetle, larva, pupa, and adult.

and the larvae which appear in enormous numbers commence feeding on the under surfaces of the leaves, completely skeletonizing them and leaving nothing but a dried framework of veins. On reaching full growth, which occurs late in June or early in July, the larvae seek shelter under bark-scales, in the grass or underground, and later in July the adults come out and deposit eggs for another generation when the entire process is repeated, being stopped only by the coming of cold weather. Sometimes this second generation is larger than the first one, but often if the spring opens late and cold, the second generation is only a small one.

The more or less complete defoliation of an elm tree once or twice in a year and coming on year after year, is sure to result in its death. This can be averted by spraying with arsenate of lead* (1½ lbs. to 50 gallons of water) when the beetles appear on the new growth early in spring and again when the larvae commence work in July. The first spray can be put on from above or below or both since the beetles devour the entire thickness of the leaf, but the second spray must be put on from the under side and directed upward since the larvae feed on the under surfaces of the leaves almost exclusively. The application of such a spray in cities offers special difficulties which will immediately suggest themselves to the reader and it is a comfort to know that elms in woodlots have really suffered less than the trees in city streets. For some reason the elms in the big forests and those in fair sized woodlots have escaped with the minimum of injury while those in parks and along boulevards and the regular plantings in the cities seem to suffer most of all.

The insect is not nearly so bad as either the gypsy moth or the brown tail moth because it feeds on elm and on elm alone..

CONTROL OF STINKING SMUT OR BUNT OF WHEAT

The Dusting of Seed Wheat with a Fungicide, Copper Carbonate is Entirely a Safe Remedy Against Stinking Smut; the Berkeley Rock Variety Gives Great Promise Because of its Resistance

G. H. COONS, BOTANICAL SECTION

In the August, 1923 Quarterly Bulletin of this Station the writer gave his experimental results in treating wheat against stinking smut (*Tilletia levis*). In this report the results of two year's tria's with copper dusts were outlined. It was shown that when using seed wheat which produced an excessive amount of stinking smut, if untreated, that it was possible by dusting of the grain with copper dusts to reduce the stinking smut to a very low percentage. It seemed evident that with ordinary seed wheat fit for planting, the use of the dust treatment would practically eliminate stinking smut.

During the fall of 1923, many farmers tried the new method and all

*In spraying near houses, care should be taken to get as little spray on the house as possible, since dark paints are frequently splotched by the spray mixture.

reports are satisfactory. Some difficulty has been experienced by farmers in securing copper carbonate for use with their wheat. The chemical has not been stocked by drug stores generally, and frequently the druggist has ordered chemically pure copper carbonate of coarse texture in place of the commercial, impalpable powder necessary for successful results. It is therefore, necessary for farmers who wish to use this method, to order the proper chemical early to avoid delay. The wholesale supply houses in the state have been informed of the probable demand and are stocking the chemical. Druggists throughout the state have been also informed through their trade journals of the probable demand.

Method of Treatment

With a new treatment, such as this, it is always found that many interesting developments in method of application take place. In the West the treatment is used on a very large scale. Seed wheat for many thou-

Fig. 10. Stinking smut of wheat, (at left). The light puffy grains are filled with the smut powder. The copper dust treatment successfully controls this disease.

sands of acres has been given the dust treatment before planting. Certain commercial concerns have developed continuous feed machines, power driven, capable of treating one hundred to two hundred bushels per hour. For Michigan conditions where wheat fields are small and the bulk of seed to be treated on any one farm is usually not over fifty bushels, it would seem that a home-made machine turned by hand would be most suitable. A cubical box holding from one to three bushels with a shaft extending diagonally from one corner to the other would quickly bring about the thorough dusting of the grain. A door built at one corner would permit the quick discharge of the contents.

An old barrel churn is ready is ready for service and brings about a thorough coating of the grain with the chemical.

Probably the simplest form of container in which to treat the grain consists of a barrel with a canvas tied or strapped over the mouth. The grain can be readily dumped into the barrel, and the requisite amount of copper carbonate applied. The cover is then tied on and the dusting is accomplished by rolling the barrel up an incline. When the dusting is complete the grain is dumped and is ready for sacking.

It is doubtful whether the dust can be applied thoroughly enough to secure perfect control of smut by merely shoveling the grain over and over. This method or the mixing of the dust on the grain as it stands in the drill box is not advised.

Poisonous Character of the Dust

Where large quantities of grain have been treated or the treatment has been carried on in a closed room, there have been some complaints of bad effects following inhalation of the dust. Unless the treatment is done in the open with a breeze to carry away the dust, it probably would be well for operators who are going to dust very much grain to provide themselves with some simple form of dust mask.

The Chemicals to be Used

In the experiments carried on at the College, copper carbonate containing 18 per cent metallic copper and diluted with gypsum as well as copper carbonate analyzing 50 per cent metallic copper have been used. These have been used at the rates of two to four ounces per bushel. Both forms of copper carbonate seem to have been equally successful in the control of smut. Four ounces per bushel is advised. We have also used a 50-50 mixture of dehydrated copper sulphate and hydrated lime. This has given practically as good results as copper carbonate. In general, due to the greater convenience of dealing with one chemical rather than two and because of the variability of hydrated lime it would seem advisable to recommend the copper carbonate as the chemical to use for stinking smut treatments.

The Advantages of the Method

The advantages of the method may be briefly summarized. Farmers recognize the heavy loss that stinking smut brings about and although formaldehyde treatment is very efficacious in reducing smut, this treatment has frequently produced such a bad effect on stand that many farmers would rather have the smut than take a chance with the formaldehyde. Properly applied, the formaldehyde treatment controls smut remarkably well but it is necessary to treat only as much grain as can be planted at once and the grain must not be given too strong a dose. If treated grain is put into the soil, the soil absorbs the formaldehyde and stops its toxic action.

On the other hand, the effect of the copper-dust treatments is rather to increase the stand because the copper-dust coating serves to discourage mold growth on the kernels. It can be given at any time and the grain, not being wet, can be safely stored.

Using commercial copper carbonate the treatment should not cost over 10 cents a bushel, and if some simple machine is available the time consumed in treating should be small. It is to be expected with these advantages that treatment for stinking smut will be largely given by Michigan farmers.

The Danger From Stinking Smut

Stinking smut is a disease which as yet has not been eliminated from Michigan seed stocks. In examinations made of farmers' samples and of samples of certified seed, stinking smut spores were found in washings from every sample tested. With some samples, the spores were very few, but still enough of the fungous spores were present to insure perpetuation of the smut. The amount of stinking smut varies from year to year, depending upon whether conditions were favorable for infection or not. In general, early planted grain which meets with good growing weather largely escapes the smut. Grain that is planted late is likely to show more smut. The 1922 and the 1923 planting seasons were especially favorable to the wheat, hence even with badly infested seed grain the stinking smut did not develop to the full extent. The farmers can not afford to take a chance, however, because a cold, damp period after the grain is planted will lead to an excessive smuttiness with untreated seed. Even if grain is fairly clean this season it may be exceptionally smutty next year if conditions favorable for infection occur this fall. The sure way to avoid the danger from stinking smut is by seed treatment.

Tests with Various Varieties of Wheat

For several years, tests for stinking smut resistance of the standard varieties of wheat have been carried on at the experiment station. In general it has been found that *none* of the varieties of wheat now popular in the state, are smut resistant to an extent sufficient to warrant farmers planting them without treatment. This may be said about the following wheats that have been tested,—Red Rock, Shepherd's Perfection, Mammoth Red, Poole, Leap, Fultz, Kanred, Zimmerman, Harvest Queen, Diehl's Mediterranean, Red Champion, Goens, Fulhio, Gladden, Ball, Sauerman, Michigan Amber, New Fultz, etc.

Certain wheats have shown marked resistance and these for the most part are wheats of hybrid origin in which Turkey wheat has been crossed with some other variety. The outstanding case of a wheat which is definitely resistant to stinking smut is to be found in the Berkeley Rock variety. This wheat has been given severe tests for three years and in spite of exposure of the seeds to an enormous number of smut spores shows only a trace of smut in the progeny. It would seem that with Berkeley Rock which is one of the varieties developed by Professor F. A. Spragg, Plant Breeder of this Station, a distinct advance in disease control, so far as stinking smut is concerned, has been made. *Berkeley Rock wheat will not need treatment since commercial fields of Berkeley Rock, because of the innate resistance of the variety, will be practically free from stinking smut.* With all of the other varieties mentioned, including Red Rock, seed treatment is still necessary. For these, the copper carbonate method, using four ounces per bushel, is recommended.

BLACK ROOT OF STRAWBERRY

A Discussion of the Disease and Suggestions to Growers Who Contemplate Starting New Plantings

G. H. COONS, BOTANICAL SECTION

For many years strawberry growers have complained of a disease called Black Root which has in many cases been serious enough to destroy whole patches. Fletcher, in his book on strawberry growing, mentions the disease and suggests that bacteria are responsible. No investigation has been made on the disease.

It is characteristic of this disease that the roots turn black and the cortex (outer part) of the root loosens and peels readily from the center of the root. Similarly, the crown of the plant may be blackened, but the heart is sound. Plants with affected roots frequently bear a crop, only to wilt and die with the warm summer weather.

The only fungus associated constantly with diseased plants is the fungus Rhizoctonia, well known in its attacks on other plants such as potatoes, beans, geraniums, etc. The diseased tissue is heavily infested with threads of this fungus. It is characteristic of the Black Scurf fungus, which attacks such a wide range of hosts, to cause a disorder of the cortex and to attack the underground parts. It would seem that Rhizoctonia might be an important factor in Black Root. Many of the cankers on the roots of strawberry are typical Black Scurf cankers.

So far as observation in Michigan goes, Black Root is worse where strawberries follow strawberries closely, as in garden soils and in very rich soil. It seems to be especially common with nursery plants which are delayed in transplanting. In seasons where the spring is excessively wet, new plantings suffer. Flooded soils, poorly drained soils, soil of fine texture which compacts readily, show a high amount of the root rot. Soils which tend to be cold, will show a higher amount of infection. These conditions under which black root is most serious are exactly the ones which favor Rhizoctonia. This is another bit of evidence as to the cause of the trouble.

It is a well known fact that strawberries winter kill when not properly mulched. Much of the suspected black root is probably winter injury. Winter injury with small plants like strawberries is apt to be most serious in a year when the snow covering is scanty and alternate freezings and thawings occur. Killing out of an entire patch in an exposed location would probably best be attributed to winter injury since a fungous disease is more apt to be irregularly distributed or to occur in patches in a field.

Control measures are difficult to outline for such a commonly occurring disease which presumably is caused by the fungus Rhizoctonia. The Rhizoctonia fungus occurs in virgin soils and is especially abundant in soils devoted to root crops. Grain crops seem to reduce the Rhizoctonia

infestation of soils. The utilization of soils which are otherwise suitable and which have previously borne grain crops is suggested for strawberry fields. Certainly strawberries should not follow strawberries. The choice of plants with sound, bright roots instead of plants with part of the roots blackened, is certainly to be advised. No method of treating roots with chemicals has been devised. These measures, along with the general ones, such as protection of the plants from winter injury, the use of proper mulch and adequate drainage, are all that can be suggested.

For a patch badly affected, the only suggestion that can be made is to improve general conditions and to stimulate new root formation from the diseased plants by use of a light dressing of well-rotted manure or by a light application of sodium nitrate or ammonium sulphate. A new source of plants should be sought for new plantings. A strong strawberry plant with sound, clean roots is worth what it costs.

Growers who contemplate starting new plantings of strawberries can avoid very much of this type of trouble, if they will bear in mind that strawberries seem to do best on sandy soil that is well drained and which tends to be acid. Given a proper location and soil which has not been infested with strawberry disease producing organisms, it is possible to obtain a full stand of strong, vigorous plants, if growers secure strawberry plants and set them out without delay. If it is desirable to secure healthy plants from other plantations these should be set out the same day as dug. Where nursery plants are secured, it is desirable that the ordinary careless handling of the strawberry shipment be avoided. The grower must bear in mind that he is dealing with a living thing which can be injured by overheating, by drying or by suffocation. The safest procedure, where soil and weather conditions permit, is to plant the shipment promptly.

HARDWOOD LANDS AFTER LOGGING

Adequate Reproduction is Secured Under Present Methods of Cutting if Fire is Kept Out

PAUL A. HERBERT, FORESTRY SECTION

During the summer of 1923 the Department of Forestry of the Michigan Agricultural College conducted a series of studies to determine the exact nature and condition of the forest growth on hardwood land immediately after logging. Further studies were made to determine the effect of fire on this second growth.

The areas chosen for this investigation were in the vicinity of Johannesburg, Michigan. This is a typical section of the hardwood region of the northern part of the lower peninsula of Michigan. The region is a rolling plain with no marked changes in type of forest vegetation due to topography. The soil is a light, sandy loam (Roselawn type) which

has been certified by the Michigan Department of Agriculture to be of value for farming. The average annual rainfall is 28.38 inches, sufficient to produce a luxuriant hardwood forest as the heaviest precipitation occurs during the growing season.

The timber stands studied, typical of the region, averaged a little over 11,000 board feet (Doyle rule) per acre. The principal species is sugar maple (Acer saccharum), making up about 71 per cent of the stand. The other species present in order of stocking are: American elm (Ulmus Americana) 16 per cent, yellow birch (Betula lutea) 5 per cent, hemlock (Tsuga canadensis) 4 per cent, basswood (Tilia Americana) 3 per cent, and beech (Fagus grandifolia) 1 per cent. Normally the amount of ground cover and underbrush is very light.

The following tables show just what remained of the original timber two years after logging:

Table 1.—Stand table—after logging—hardwood type—per acre
(Based on six, one acre plots.)

*D. B. H. inches	Hard maple	Hemlock	Beech	Elm	Basswood	Total	Percent
1	none						
2	3	1.3	1	2.3		7.6	13
3	2	1.3	1	2	.2	6.5	11
4	2	3.0	1.3	1.2		7.5	13
5	2.2	2.0	1.5	1.2	.2	7.1	12
6	3	2.8	.7	8	.7	8.0	14
7	1.7	1.0	1.5	.3	3	4.8	8
8	1.7	.5	1.5		.5	4.2	7
9	1.5	1.3	8		7	4.3	8
10	1.2	1	.8			3.0	5
11	1.2	.3	1.5		7	3.7	6
12	.5	.2	1.0			1.7	3
Total	20.0	14.7	12.6	7.8	3.3	58.4	100
Percent	34	25	22	14	5	100	

*D. B. H.—Diameter at breast height, i. e., 4.5 feet above the ground.

Table 2.—Increment and volume of trees left after logging.

	Number	Volume	Increment percent	Periodic annual increment
Maple	20	114 cu. ft.	6	6.8 cu. ft.
Beech	12.6	75 cu. ft.	7	5.2 cu. ft.
Hemlock	14.7	45 cu. ft.	2	.9 cu. ft.
Elm	7.8	23 cu. ft.	8	1.8 cu. ft.
Basswood	3.3	14 cu. ft.	6	.8 cu. ft.
Total per acre	58.4	271 cu. ft.		15.5 cu. ft.

In addition to this, the ground was densely covered with reproduction, weeds, and underbrush that had come in after the logging or just prior to it. An average acre contained the following ground cover: Violets (Viola sp.) 16,000, red raspberry (Rubus idaeus) 10,000, Hazlenut (Corylus sp.) 9,000, grass (Gramineae) 2,000, dandelion (Leontodon sp.)

1,440, solomon's seal (Polygonatum) 1,300, Indian turnip (Arisaema triphylum) 1,280, clover (Trifolium sp.) 800, elder (Sambucus sp) 640, thistle (Cirsium sp.) 320, pigweed (Chenopodium sp.) 300, shepherd purse (Bursa sp.), morning glory (Convolvulaceae) 160, and burdock (Arctium sp.) 150. Besides these, the following reproduction was found on an average acre: Maple 25,168, beech 4,840, basswood 1,936, and elm 968.

Table 3.—Size and origin of maple reproduction.

Height	Seedling percent	Sprout percent
1 inch	40	18
2 inches	18	7
3 inches	1	3
4 inches	1	1
4 inches (over)	.5	1
Totals	60.5	39.5

These figures and tables show that an adequate number of forest trees are present upon this area to assure a future crop. The temporary cover of weeds and underbrush will for a time retard the growth of the tree reproduction but, on the other hand, it will materially help in protecting the exposed site from deterioration. The trees left by the wood cutters are either defective or too small to be merchantable. Most of the larger, defective trees (3 per acre) will doubtlessly die or be wind thrown before the second crop is merchantable. Those that do remain will be worthless, and will be occupying space upon which valuable timber trees could be growing. Many of the trees in the smaller diameter classes have been injured in logging or are suffering from the changes in the physical and biotic factors brought about by logging. Some of these trees are dying and many others will probably be worthless when the second crop is ready to cut. As this entire group of trees, left from the original stand, only numbers 58.4 per acre, (Table I) and since many of these will disappear, the bulk of the future timber must come from the reproduction now numbering 32,912 per average acre. A careful study of the age of the tree reproduction on the area shows that less than 5 per cent of it is the result of seed shed, after logging, from the trees left on the area. For these reasons it would seem that little is gained by leaving any trees on the area when the crop is harvested *if fire is subsequently kept out.*

It is generally accepted that a fire burning over an area after logging will kill all the reproduction, but in most cases it only injures the larger trees left behind. These trees then bear seed (the injuries increase the seed production) which will replace the reproduction destroyed by the fire. Studies show that this conception may hold for one fire especially if it is a light one, but that repeated fires or exceptional severe fires, as often occur in hardwood slash, bring about the death of these trees and thus prevent them from bearing seed to restock the area.

Plots were taken on two areas, one repeatedly burned over since logging, and the other showing evidence of none or only one light fire.

The conditions prevailing on these two areas have been listed for easy comparison:

Unburned	Burned
Forest Floor	
Litter: One inch. Humus: 4.5 inches.	Litter: .5 inch. Humus: 1 inch.
Ground Cover	
None.	Moderate consisting of weeds (1,024,000), ferns (14,000), grass (20,000), clover (10,000).
Under-Brush	
Very little. Service berry (1,000).	Moderate: Raspberries (60,000), elder (5,000), etc.
Reproduction	
Hard maple (2,400), elm (500).	Pin cherry (4,000), willow (7,000), aspen (2,250).
General Condition	
All trees healthy, straight boled and growing vigorously. Canopy complete: site well protected.	The few trees that survived the last fire show slow growth and scarred bases. Growth on all trees much slower than on other area. Site covered with grass and weeds: conditions adverse for regeneration.

Table 4.—Stand table—per acre—unburned area.

D.B.H. inches	Maple		Basswood		Elm		Ironwood		Total		Percent	
	Seedlings	Sprouts	Seedlings	Sprouts	Seedlings	Sprouts	Seedlings	Sprouts	Seedlings	Sprouts	Seedlings	Sprouts
1	240	1,480				40			240	1,520	7	42
2	80	560			120				200	560	5	16
3		200		80						280		8
4	80	80		80			160		240	160	7	5
5	40			80			40		80	80	2	2
6	40			80					40	80	1	2
7				80						80		2
8				40						40		1
Totals	480	2,320		440	120	40	200		800	2,800	21	79
Total	2,800		440		160		200		3,600			
Percent	15	65		10	3	1	5					

Table 5.—Stand table—per acre—burned over.

D. B. H.	Maple	Popple	Elm	Willow	Pin Cherry	Service Berry
1..........	40	2,000	40	1,500	100	40
Total..						3,600

This data shows that fires have consumed all the trees left in logging, killed practically all the valuable reproduction, and left the site in such a condition that it is very difficult for tree seed to germinate and grow. It would seem, then, that trees left in logging may aid for a short time in restocking a forest area but that fires in this region soon destroy them and leave the area generally unsuitable for tree growth.

Note:—The Forestry Section of this station is inaugurating extensive experiments in forest tree breeding and desires information as to the location of trees with exceptional qualities worthy of perpetuating.

ROTATION OF CHEMICAL ELEMENTS IN AGRICULTURE

SULPHUR

WARD GILTNER AND R. M. SNYDER, BACTERIOLOGICAL SECTION

The element sulphur has come to be recognized in recent years as having an important place in our agricultural economy. Sulphur bears a resemblance in many respects to the element nitrogen, which we discussed in the February number of the Quarterly. They are both oxidized and deoxidized by soil organisms, both are carried down on to the soil by the rain, and they both leach out readily into the drainage water. Aside from decomposing organic material, the sulphur in the air may come from two other sources as well,—the combustion of coal, and volcanic action.

Starting at the upper right hand corner of the diagram, we note the element sulphur indicated by the letter "S." Bacteria in the soil may oxidize sulphur to higher oxides, and ultimately sulphuric acid, which combines with bases present to form sulphates. This action takes place if elemental sulfur is added to any well aerated soil, although the speed of the oxidation may depend on the number of sulfur oxidizing organisms present. This has led to the proposal to add artificially these organisms to the sulfur, in order that when applied to the soil, the oxidation process may be hastened. Much work remains to be done before the place of "inoculated sulfur" is definitely established in farm practice. The oxidation of sulfur results in an increase in soil acidity. It is frequently desirable to increase the acidity of a particular field, in order to control such diseases as potato scab.

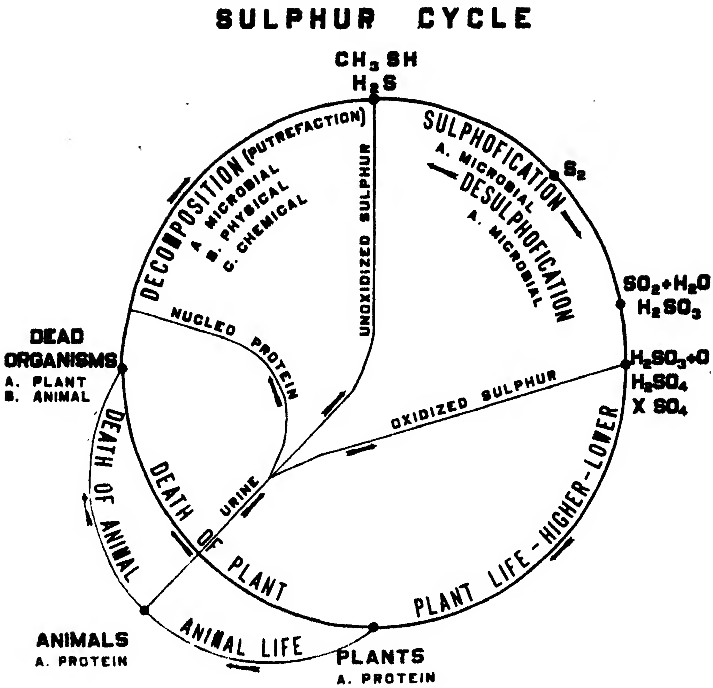

Fig. 11.—A graphic illustration of the sulfur cycle.

The soil sulfates, being dissolved in the soil solution, become easily incorporated into the plant tissue. Sulfur is an important constituent in protein material. It is not surprising, therefore, that in cases in which the sulfur content of the soil is low, the application of this element either singly or in combinations such as gypsum may result in increased plant growth.

Continuing the rotation, the plant may die and the plant material return to the soil, or the plant may be consumed by an animal. In the latter case, the sulfur may be thrown off in the animal excretions, or it may be incorporated into the soil with the death of the animal body. In either case, the material in the soil is reduced by microbial and physico-chemical agencies to form the gas known as hydrogen sulfide. The hydrogen sulfide may then be oxidized, and thus we have completed the cycle through which the element may pass. The subsidiary lines within the main cycle indicate that the sulfur in the animal excretions take their places in the cycle, depending on their respective degrees of oxidation.

It is only within recent years that the role of sulfur in the plant and in the soil has been given intensive study. It is expected that the next few years will reveal much regarding the place which this element may occupy in our future agricultural operations.

FALL INOCULATION OF VETCH

The Proper Application of Artificial Inoculation to Pea or Vetch Seed Usually Results in an Increased Crop

R. M. SNYDER, BACTERIOLOGICAL SECTION

A small amount of vetch is sown in Michigan in the spring. The greater portion, however, is reserved for fall sowing, and the question arises whether or not it should be inoculated.

We feel that it is desirable to inoculate every legume, provided the bacteria producing nodules on that particular legume, are not present in the soil in sufficient degree to produce an abundant supply of nodules. The organism producing nodules on vetch is the same strain which produces nodules on field peas. This strain is distributed to some extent over the state. We find, however, that notwithstanding this fact, the proper application of artificial inoculation to pea or vetch seed usually results in an increased crop. A plant well loaded with nodules is the thing desired. If the bacteria are not sufficiently abundant in the soil to produce this result, artificial inoculation may be resorted to with profit. Peas and

Fig. 12. Illustrating the influence of artificial inoculation on field peas in Ontonagon county. The peas on the right were uninoculated, on the left, inoculated. Photo used through courtesy of Ontonagon Farm Bureau.

vetch are different in their habit of growth and also in the use to which man has put them, yet when we examine more closely into their physiology, we find certain resemblances that are striking. They are closely related botanically and are equally tolerant of soil acidity, being in that respect at a point midway between alfalfa, our least tolerant legume, and soy beans, our most tolerant. As has already been pointed out, they

are both inoculated by the same strain of bacteria, and consequently they will cross inoculate: that is, an old pea field will be inoculated for vetch and vice versa. The accompanying illustration shows an increase in growth obtained on field peas last season in Ontonagon County. The portion of the field on the right hand side of the picture was uninoculated and that on the left, inoculated.

The question naturally arises: how may the farmer know whether a certain field to be sown to a legume is already inoculated? The crop-history is the only thing that we can use in obtaining an answer. If the field has grown the legume to be planted, or some other legume which is inoculated by the same strain of bacteria, with good nodule production within the past four or five years, then we may be reasonably certain that the field is still provided with the proper bacteria. But, if nodule production was not abundant, or if, as so frequently happens, the farmer is not sure of the crop-history of the field under consideration, then it is desirable to artificially inoculate.

In order to inoculate a field for vetch, soil may be hauled and distributed from an old vetch or pea field. Usually three or four hundred pounds per acre is sufficient. If this soil is not readily available, an artificial culture must be resorted to. These artificial cultures may be obtained from a number of commercial concerns or from the Bacteriological Laboratory, East Lansing, Michigan. In many cases county agents carry cultures in stock for those who desire them. The application blank to be found at the end of this quarterly bulletin may be torn out and used to apply for cultures for vetch or any other legume. The various departments in the experiment station will gladly answer any questions that may arise in this connection.

APPLICATION BLANK

For Nodule-Forming Bacteria

Name ....

Post Office ....

County ....R. F. D.............

Note.—No cultures can be sold for use outside of Michigan.

Cultures for nodule-forming bacteria are supplied for: Alfalfa, Sweet Clover, Red Clover, White Clover, Alsike Clover, Field and Garden Beans, Soy Beans, Garden and Canada Field Peas, Cow Peas, Vetch. One strain of the bacteria is effective for Alfalfa and Sweet Clover; another for common clovers, Red, Mammoth, Crimson, Alsike and White.

Crop to be planted ....

Total bushels of seed to be planted...

(If a mixture is being planted, give the amounts of each variety of seed.)

Probable date of seeding..

(Cultures should be secured just before seeding. They should be kept but twenty days. Cultures are sent about one week before the time specified for seeding.)

One culture inoculates one bushel of seed. A nominal charge of 25 cents per culture is made to cover cost of material and shipping.

Enclosed find $................ Date..

(Do not send postage stamps.)

I am applying for cultures with the understanding that I will use them according to directions, and will report results at the end of the season.

(Sign here)..

This sheet when filled out should be addressed in a sealed envelope to,

BACTERIOLOGICAL LABORATORY,
Michigan Agricultural College,
East Lansing, Michigan.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, East Lansing, Michigan.

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Regular Bulletins—

251 Insects of 1907.
258 Insects of Field Crops.
262 Suggestions on Planting an Orchard.
264 Second Report of Grade Dairy Herd.
267 Michigan Weeds (only to libraries and teachers).
273 Utilization of Muck Lands.
277 Studies in the Cost of Market Milk Production.
281 Trees, Shrubs and Plants for Farm and Home Planting.
284 Some Information and Suggestions Concerning the Use of Phosphorus.
286 Studies and Cost of Milk Production—No. 2.
289 Corn Growing in Michigan
290 Soil Fertility.

Special Bulletins—

58 Foul Brood.
65 Hog Cholera and Preventive Treatment.
67 Onion Culture on Muck Lands.
70 Michigan Agriculture, Its Present Status and Wonderful Possibilities.
71 Studies in the Range and Variation of the Percent of Butter Fat in the Milk of Individual Cows.
72 Some Ginseng Troubles.
74 Analysis of Some Materials Sold as Insecticides and Fungicides.
76 Transferring Bees.
79 Michigan's Shifting Sands; Their Control and Better Utilization.
80 Yellow Rocket (a dangerous weed).
81 Tomato Leaf Spot.
82 Durability of Concrete Drain Tile No. II.
83 Key to Orthoptera of Michigan.
84 Strawberry Culture.
90 Special Report of the Upper Peninsula Experiment Station.
91 Some General Information on Lime and Its Uses and Functions in Soils.
94 The Financial History of a Twelve-Year-Old Peach Orchard.
95 Muskmelon Culture in Michigan.
98 Vinegar.
99 The Detroit Commission Plan of City Milk Administration.
100 Soy Beans.
101 Oats in Michigan.
102 Dusting and Spraying Experiments of 1918 and 1919.
103 Forest Planting in Michigan.
104 Soils of Detroit Area.
105 Rosen Rye.
106 Sugar Beet Growing in Michigan.

107 Diseases of Bees in Michigan.
108 The Robust Bean.
109 Dependable Michigan Crop Varieties.
110 Special Report of the Upper Peninsula Experiment Station.
111 Studies in City Milk Distribution.
112 An Experiment in Improving the Milk Supply of a City Milk Plant.
113 Sweet clover.
114 Spray Practice Outline.
116 The Agriculture of the Upper Peninsula of Michigan.
118 Pruning Fruit Trees.
119 The Septic Tank and Sub-Surface Tile Sewage Disposal System.
120 The Microscopic Identification and Determination of the Specific Ingredients in Stock Feeds.
121 Grape Production in Michigan.
122 Improvement of the Farm Woodlot.
123 Second Growth Hardwood Forests.
124 The Colormetric Hydrogen-ion Determination as a means of Locating Faulty Methods at City Milk Plants.
125 Michigan Potato Diseases.
126 An Analysis of the Peach Variety Question in Michigan.
127 Nitrogen-Carrying Fertilizer and the Bearing Habits of Mature Apple Trees.
128 Sandy Soils of Southern Peninsula of Michigan.
129 Bean Growing in Michigan.
130 The Clovers and Clover Seed Production in Michigan.
131 Tomato Growing in Michigan.
132 Field and Garden Insects.
133 Fertilizers. What they are and how to use them.
134 Greenhouse Insects.

Circular Bulletins—

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14 Top Working Apple Trees.
28 The Bean Maggot in 1915.
30 Cucumber Growing.
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36 Planting the Rural School Grounds.
37 Raspberry Culture.
43 Increasing the Production of the Bearing Apple Orchard.
44 The European Corn Borer.
47 Poisoning from Bacillus Botulinus.
48 Spraying for Hopperburn.
49 The Hessian Fly.
50 Hairy Vetch.
51 The Chinch Bug.
52 The Grape Berry Moth in 1922.
53 Standard Fertilizers for Michigan.
55 Lime Requirement for St. Joseph County.
56 Lime Requirement for Cass County.
57 Lime Requirement for Calhoun County.
58 Lime Requirement for Berrien County.

59 Lime Requirement for Ottawa County.
60 Lime Requirement for Kalamazoo County.
61 Paying for Milk on a Quality Basis as a Means of Improving the Supply.
62 The Simplex Lime Spreader.
63 White Ants.
64 Simple Water Systems.

Technical Bulletins—

List of Available Bulletins Sent Upon Request.

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Vol. I, No. 2, November, 1918
Vol. I, No. 4, May 1919
Vol. II, No. 1, August, 1919
Vol. II, No. 2, November, 1919
Vol. II, No. 3, February, 1920
Vol. II, No. 4, May, 1920
Vol. III, No. 1, August, 1920
Vol. III, No. 2, November, 1920
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Vol. VI, No. 1, August, 1923
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Vol. VI, No. 3, February, 1924
Vol. VI, No. 4, May 1924.
Vol. VII, No. 1, August 1924

Home Economics Bulletins—

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20 Clothing for Children.
21 Care of Clothing.
26 Layettes.
27 Jellies, Jams, etc.
28 Home Canning Guide.

Extension Series Bulletins—

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4 The Home Vegetable Garden
10 Rosen Rye.
11 Good Seed Means More and Better Corn.
13 Oat Smut and Its Control.
14 Spray Formulas for the Home Garden.
17 The Stinking Smut of Wheat.
19 Grasshopper Control.
20 Hotbeds and Coldframes.
[illegible]2 Effective Crops Exhibits.
[illegible]3 More Alfalfa for Michigan.
[illegible]5 Feeding Cull and Surplus Potatoes.
[illegible] Swine Feeding
[illegible]7 The Kitchen Sink.
[illegible] Feeding for Egg Production.
[illegible] The Baby Chick.
[illegible] The Production of Hardigan Alfalfa Seed.
[illegible] Capons.
[illegible] Cow Testing Associations and Bull Associations.
[illegible] Setting a Standard for Seed.

Club Bulletins—

2 Potato Club Work.
3 Bean Club Work.
5 Pig Club Work.
7 Corn Club Work.
10 Canning Club Work.
12 Hot Lunch Project.
14 Organization of Calf Clubs.
15 Food Study Club Work.

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Regular bulletins include all publications reporting investigation work in connection with subjects of general interest and handled in a more or less popular way.

Special bulletins are bulletins of a popular nature and dealing with special lines of work.

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Technical bulletins, as the name implies, are devoted to reports of scientific research and designed more especially for use of other investigators, instructors and students.

Quarterly bulletins contain contributions by all sections of the Experiment Station. It is issued during February, May, August and November of each year. Copies are sent to the entire mailing list. The Quarterly also contains a list of all available bulletins.

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THE QUARTERLY BULLETIN

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MICHIGAN AGRICULTURAL COLLEGE

East Lansing, Michigan

VOL. 7 NOVEMBER, 1924 NO. 2

ISSUED DURING
FEBRUARY, MAY, AUGUST AND NOVEMBER

CONTENTS

EDITED BY
R. S. SHAW AND E. B. HILL

CONTRIBUTIONS BY ALL SECTIONS OF THE EXPERIMENT STATION

FEEDING SOFT CORN

With High Priced Corn the Feeding of Protein Supplements to Balance the Ration is More Important Than Ever

G. A. BROWN, ANIMAL HUSBANDRY SECTION

Livestock producers are confronted with serious feeding problems for the coming year. In view of the present price of feedstuffs many producers are inclined to curtail operations and market their animals before they are finished and ready for market. This always results in a livestock shortage, correspondingly higher prices, and as a result very remunerative returns to the man who ca: plan his business in a way that will enable him to continue as near to normal production as conditions will permit.

The utilization of the immature, soft-corn crop this fall and early winter is a difficult problem. Any corn which can be stored in the crib and held for feeding next spring or summer should be so handled. There is, however, a large amount of soft corn, containing too much moisture to be stored, which must be consumed at once. Many people are of the opinion that soft corn has very little feeding value. Owing to the high moisture content of soft corn, its value per bushel is not nearly so great as that of mature, hard corn. Repeated trials have shown, however, that a pound of dry matter in soft corn is as valuable for feeding purposes as a pound of dry matter in mature corn. In ordinary years, at this season, corn contains about 20 per cent moisture—125 pounds of corn giving 100 pounds of dry matter. This year a great deal of our soft corn contains as much as 40 per cent moisture. One hundred sixty-six pounds of such corn would be required to give the same amount of dry matter and the same feeding value as 125 pounds of corn containing only 20 per cent moisture, as it would in a normal year. As a result of the high moisture content, soft corn must be fed in larger amounts and from three to five times daily, instead of only twice daily as with normal corn. Owing to the greater capacity of their digestive tracts, cattle or sheep can handle soft corn to better advantage than can hogs. The soft corn should be fed first, leaving the better corn for finishing the animals. The most satisfactory method of handling the soft corn is to turn the animals directly into the fields, letting them do their own harvesting. Where this is not feasible, the corn should be left on the standing stalks or in small shocks and picked or husked as it is used. When possible, soft corn containing frost should be thawed out before feeding.

Every man who is feeding any class of livestock this year must en-

deavor to conserve grain and make that which he does use go as far as possible. This can be accomplished in large measure by careful attention to the health and thrift of the animal, combined with a well balanced ration. The first step in this direction lies in the liberal use of leguminous roughages, such as clover and alfalfa hay. With abundance of leguminous hay and plenty of corn, it is not always economical to purchase protein supplements. With corn as high in price as it is at present, however, the purchase of sufficient protein supplements properly to balance the ration will prove advantageous. For cattle or sheep feeding, the judicious use of cottonseed meal, linseed meal, or cull beans is desirable; while for swine feeding the use of dairy by-products, cull beans, or digester tankage, in combination with corn, will materially reduce the amount of feed required to produce 100 pounds of gain.

On many farms, perhaps little or no corn will be available for feeding purposes, leaving the feeder dependent on substitutes. Barley, rye, or damaged wheat may all be used to replace corn, and in many sections of the state considerable quantities of cull beans will be available. In so far as is possible, farmers should anticipate their needs and lay in their supplies of the above feeds before they are shipped out of the state. In no case should valuable breeding stock animals be sent to the block unless, after a careful analysis of conditions, it is found impossible to retain them.

A situation such as that existing at present usually results in a temporary shortage of live stock, and this in turn in a lessened demand for grains and a lowering of grain prices much sooner than would be the case could normal live stock production be continued.

AN AUTOMATIC SWITCH FOR POULTRY HOUSES

A Simple Inexpensive Device for Turning on Lights in Poultry Houses

C. M. FERGUSON—POULTRY SECTION

Artificial lights are no longer regarded simply as an experiment or a fad when they are used to increase winter egg production. Repeated trials with poultry flocks have proven beyond a doubt the value of longer working days during the winter months. Yearly egg production has not been materially increased, but yearly distribution has been changed. The heavy egg production, which normally comes with the advance of spring weather and longer days, can be distributed over the winter months when egg prices are higher, by the use of lights.

We find poultrymen following various methods of using lights, all however, attempting to lengthen the working day and to increase the amount of feed consumed. The following methods are commonly used:

(1) morning lights, (2) evening lights, (3) night lunch, (4) combination of morning and evening lights.

These methods need but little explanation. Morning lights are usually turned on about 4 or 4:30 a. m., and allowed to stay on until daylight. Evening lights are turned on at dusk and left on until 8 or 9 p. m. This method requires a dimming device in order to create a sunset effect and get the birds all to roost. The night lunch method allows the birds to go to roost after being fed a light feed of grain before dusk. About 8 p. m. the lights are turned on and the birds fed what grain they will clean up, the lights are left on just long enough to allow the birds to clean up the feed.

Regularity in the use of lights, as well as in feeding, is essential to success. We find both electric lights and gasoline lanterns in use for poultry house illumination. Electric lights are more satisfactory. They can be regulated by automatic switches, which are more regular than the hired man, particularly in the morning.

Morning lights are giving the best satisfaction, according to results obtained from New Jersey farms. Mr. W. Allen, Extension Specialist for New Jersey, reports better results with morning lights than with the night lunch method. Where the morning light method is employed, the feed is put in the pens for the birds after they have gone to roost. The lights are automatically turned on early in the morning and are then turned off at daylight. A dimming device is not necessary.

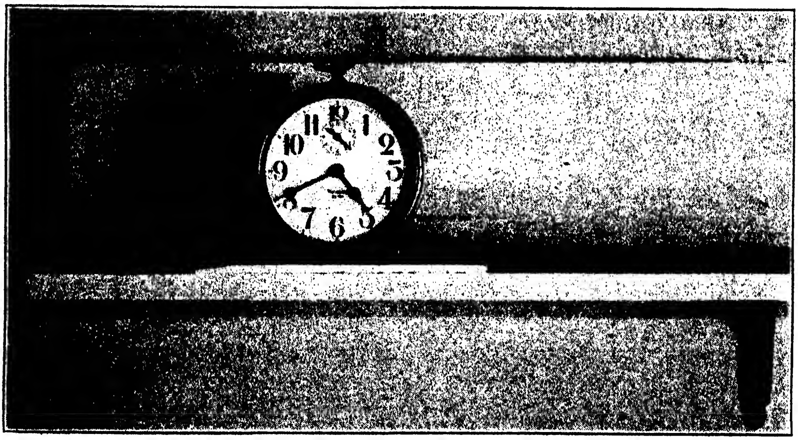

Fig. 1. Showing the poultry house switch equipped with weighted lever and alarm clock set in position. In the illustration the lights are set to go on at 4:30; the time has passed and the lever dropped, turning the lights on.

To turn on the lights, an alarm clock having a winding stem which turns when the alarm is released is employed. It will be necessary to secure a clock of the illustrated type, having the winding stem on the right side. Otherwise, when the lever is released, it will interfere with the other attachments on the clock. The clock is placed on a shelf in front of the lever. The end of the lever is bent at 90 degrees

in the direction of the clock and allowed to rest on the end of the winding stem. It will be necessary to cut out a section of shelf to allow the lever to swing "free" if the lever is longer than the distance from the winding stem to the shelf.

When installing the switch, adjust it to a position which will allow the lever to rotate far enough to complete the contact. In the illustration, the weight has been dropped and the lights are turned on. To turn the lights off the lever is moved in a clockwise direction to the next position. In order to facilitate setting, a small strip is attached to the shelf with small holes bored to accommodate the feet of the clock.

The clock is wound and the indicators moved to the time at which the lights are to go on. The alarm stem is given a couple of half turns and left in a horizontal position. The clock is placed in position and the lever moved around until it rests on the winding stem. When the alarm rings, the stem moves into a vertical position allowing the lever to drop off, turning the switch far enough to turn on the lights.

A wooden lever can be attached to a switch quite easily. A piece of oak or other material which will not split readily should be used. This should be 1½"x⅝" at the switch end and may be tapered off on the weighted end. A hole is bored large enough to accommodate the button of the switch. To make it secure, a saw cut is put in from the end beyond the button to permit clamping the lever securely to the button. This is done by putting a 2" stove bolt through the end and tightening it sufficiently to apply enough pressure to hold the lever firmly on the switch button. If further information in regard to this device is desired, write to the Poultry Department, M. A. C., East Lansing, Michigan.

THE CORN SITUATION

Michigan Growers Should Make an Extra Effort to Insure a Supply of Dependable Seed Corn for Spring Planting

J. F. COX, FARM CROPS SECTION

Owing to the general lateness of the corn crop and the cool growing season that has prevailed throughout Michigan, the crop in general is late in maturing and carries an unusually high percentage of moisture. At this date, October 9, the frost has stopped the growth of corn in northern corn regions and in low areas throughout lower Michigan. If seed corn is handled in the usual way, a large percentage of it will be of low germination at planting time. Careful methods must be followed in order to secure high quality seed.

Growers who have desirable varieties, sufficiently mature for seed purposes, should field select seed corn and dry immediately in a well ventilated place, using artificial heat is needed. Supplies of well rip-

ened corn of good varieties, particularly of the Golden Glow, Pickett, M. A. C. Duncan, Laughlin and Folk's White Cap, should be carefully selected for seed purposes and properly stored.

The corn crop is late, and high in moisture throughout the corn-belt, and frost has stopped growth in many of the corn-belt states at this time. Apparently a general seed corn shortage can be expected next spring. If Michigan growers properly select and cure their own seed, or, if their fields are not sufficiently ripe, select seed from the best fields in the neighborhood, sufficient seed for Michigan's use can be saved.

Corn stored in cribs this season will carry much more moisture than usual. Spoilage can be prevented by thoroughly ventilating the cribs. An effective method is to build a partition down the center of the crib, with two-by-fours and siding, which will leave an air space a foot or more in width. Others use chicken wire on two-by-fours in making partitions through the crib. Tile, laid at six-foot intervals crosswise, in layers three feet apart, also greatly aids in drying corn carrying too much water.

The sprinkling of five or ten pounds of salt over each hundred bushels of corn, as it goes in the crib, aids in preventing molding.

The softer corn should be fed first and the harder, more mature corn reserved for later feeding.

VALUE OF HARDY ALFALFA*

High Seed Yields Were Secured on a Field of Hardy Alfalfa for a Period of Seven Years

FRANK A. SPRAGG, FARM CROPS SECTION

In the spring of 1908, the Station received a number of lots of northern grown alfalfa seed through the U. S. Department of Agriculture. They were drilled in a series of plats on a piece of corn land, at the rate of six pounds of seed per acre, April 1908. The crop was clipped high two or three times to control weeds, and then a small cutting of hay was obtained that season. The piece of land went into the winter with a small growth of alfalfa to catch the snow.

During the first three years, individual plat yields were obtained. None of the lots winter-killed, as was the regular farmer's experience with alfalfa. It was clearly not a varietal series as the varieties of that time ran. This was a selected group of northern grown alfalfas. Considering these and the other aspects of the situation, the individual

*Note:—This is the last article contributed by Professor Spragg before his death in an automobile accident Aug. 12, 1924.

plat yields were discontinued after the third year and the piece, nearly an acre, was then cut as a whole. The purpose now was to determine how long truly northern grown alfalfa would endure, and how much it would produce under Michigan conditions.

Four cuttings of hay were obtained three times during the next seven years and three cuttings were obtained on each of the remaining years. If we include the small cutting of .86 of a ton the same year that the seed was sown, the total production for the seven years was 38.4 tons of cured alfalfa hay per acre. Forgetting the first year when the alfalfa had not yet established itself, the total was 37.54 tons per acre during the seven year period. This is an average of 5.36 tons per acre per year.

As the yield on the second year was 5.19 tons and on the seventh year 5.72 tons per acre, the indications were that the piece of alfalfa was really good for several more years. June grass had filled in the space among the plants but had clearly not injured the production of alfalfa hay. This seems to indicate that June grass does not injure the truly hardy alfalfa. On the other hand, if the alfalfa is not suited to Michigan and is killed, no one should object if its place is filled by June grass. The detailed yield for this field follows.

TABLE I.—The yields of a field of hardy alfalfa, over a seven year period.

Year	Cuttings of hay obtained				
	1st	2nd	3rd	4th	Total
1909	2.14	2.11	.94	....	5.10
1910	2.62	2.04	1.13	.66	6.45
1911	1.54	.60	.90	....	3.04
1912	2.72	1.83	1.57	....	6.12
1913	2.41	1.28	.56	1.84	6.09
1914	2.61	1.23	1.09	....	4.93
1915	2.50	1.22	1.35	.65	5.72
1916	Plowed	up.			

During this time, no attention was given the new sprouts indicating that a new crop is on the way. The first crop was cut when alfalfa blooms began to show, and as the season advanced the crop was a little further in bloom. The last cutting was usually obtained when the crop was fully in bloom. A fourth cutting was obtained only when a fifth growth could be expected to catch the snow during the winter, care being taken not to cut the last growth too short.

As only six pounds of seed was sown, the resulting stand was not thick; each plant had a chance to develop.

THE HOME STORAGE ROOM

A Simple Design for a Winter Storage Room Which is Well Adapted for Farm and City Homes

H. J. GALLAGHER, AGRICULTURAL ENGINEERING SECTION

Every housewife is continually confronted with the problem of food supply. This problem is much easier solved if the person has the opportunity of visual selection, as is clearly shown by observing the average purchaser in a grocery store. But having to continually run to the grocery is expensive, one loses time and pays a retail price. The home store-room brings, in part, the grocery store to the home and brings it at a wholesale price.

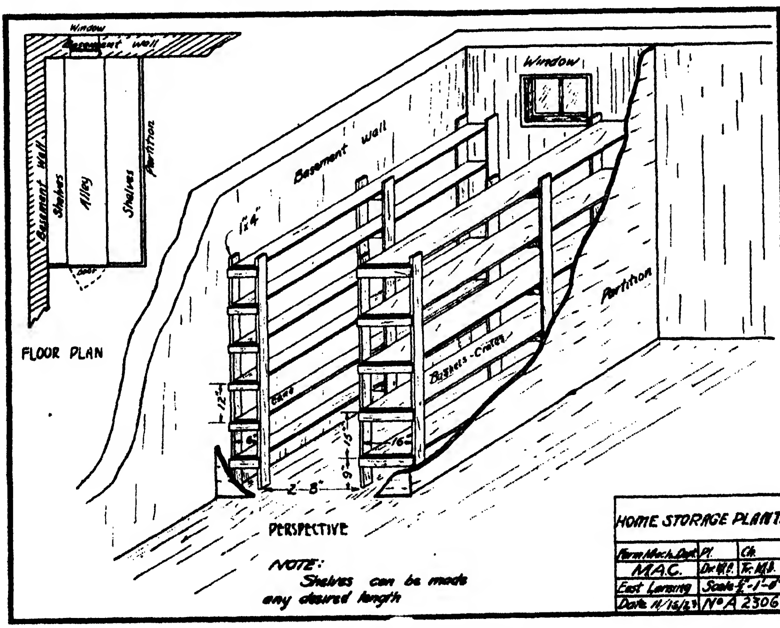

Fig. 2. An outline drawing showing the general plan and type of construction of a good farm storage room.

The problem of home storage in the city has been somewhat neglected. However, the increasing cost of living has established a need for some such device. The writer has many times been on the city market where

the farmers offer for sale select farm produce at the various harvest seasons when prices are always the lowest, and heard the comments of the buyers lamenting the fact they could not buy in quantities and at the attractive prices listed because they had no place for storage, knowing full well they would later pay a fancier price for the same article which often becomes inferior through numerous handlings.

In the country, storage has always been a necessity. It is indeed rare that a farm house is not provided with a supply of potatoes, apples, cabbage, turnips, onions, carrots, squash, and canned fruits and vegetables. While the store room has been a fixture in the country home it has, in many cases, lacked the essentials that make it a success, namely those of good ventilation, proper temperature, and the correct humidity. Especially is this true in the proper storing of raw fruits and vegetables where the foregoing factors are necessary. It was with the idea of perfecting the country home store room and providing the city housewife with a like advantage, that this type of store room was designed.

The size of such a room varies in length according to the family needs. The width remains more of a constant. For instance, the width of shelves for canned fruit need not exceed 6 to 8 inches which would allow for two rows of cans, thus giving the housewife the advantage of seeing the contents of each fruit can. The width of the shelves for bushel baskets and crates should be from 14 to 16 inches. Between the two tier of shelves should be a 2′ 6″ or 3′ alley for convenient passage and to provide for a door. The spacing of the shelves should be one foot for the canned fruit and fifteen inches to accommodate the bushel baskets. This in a basement of ordinary height would allow for six shelves of cans and five of baskets. The bottom shelf in each case should be about nine inches from the floor to permit easy mopping and sweeping. Such a room, 8 feet in length would store 382 pint fruit cans and 35 bushel baskets or crates which would provide ample storage for a good sized family.

The most desirable place of installation is in a corner of the basement, convenient to the stairway and as far removed as possible from the furnace. When located in a corner, the basement walls will furnish one end and one side of the store room, so that only material for the additional side and end are needed. When in the same room as the furnace it is necessary to obtain better insulation. Two thicknesses of sheathing with a layer of building paper between should give excellent results, as does a single thickness of matched lumber, which is the more attractive in appearance.

It is essential that the fruit room have a window, preferably between the two tier of shelves. This window should be tightly screened on the outside and hinged to swing freely on the inside and should be provided with a catch which would enable the housewife to keep it open at any desired height. It is the operation of this window which will be the main factor in the control of humidity, ventilation and temperature. Under the most severe weather conditions it may be advisable to close the window at least part of the time and to open the door and allow some heat to enter, but at all other times the window should be open and the door closed.

Bill of Material for 8′ room.

16 pcs. 1″x6″x8′ for shelves, 64 bd. ft.
6 pcs. 2″x4″x8′ for studs, 32 bd. ft.
60 bd. ft. 1″x4″x6′ for legs and cleats, 60 bd. ft.
120 bd. ft. matched lumber for side, floor and end, 120 bd. ft.
Total, 276 bd. ft.

1 pr. 3″ tee hinges..........	$.15
1 rimlock complete.........	.65
3 lbs. six penny nails.......	.24
276 bd. ft. lumber at 6c.....	16.56
One day labor in construction	6.50
Total price...........	$24.10

CONCRETE LINE POSTS

A Type of Post Which can be Made on the Farm and Used Where Conditions are Favorable

H. H. MUSSELMAN, AGRICULTURAL ENGINEERING SECTION.

Due to the large supply of cedar posts which has been available in practically all sections of the state, concrete fence posts have not attained wide use. Although having certain limitations, their use will probably become more general for this purpose as suitable wood disappears, and as facts regarding their construction and period of usefulness become established.

Concrete posts are usually of good appearance, and it is generally assumed that they have a long period of usefulness. Their weight, cost, and inability to withstand shock are their chief disadvantages. The construction of concrete posts is one of the things which is worth doing the best possible way, if done at all. Poorly built posts will give unsatisfactory results and will entail so much additional labor in replacing that no excuse can be offered for making them. After examination of the construction and method of making line posts, it will also be realized that every one of the several steps in their making must be carefully watched to insure success. It is with a view to better construction methods that the following suggestions are made.

Cement posts can be produced at a figure comparable with the cost of cedar posts (1) when sand and gravel are easily available, (2) when cement is available at a reasonable price, and (3) where time can be employed to advantage on this work. This applies especially to sections of the state where transportation effects the cost of wood materially.

Concrete line posts must contain steel reinforcement. Concrete has no property within itself for resisting tension or pull. Steel used for this purpose is generally placed in the concrete at a place which tends to separate or open when stress occurs. A concrete beam supported at both ends and having the load or weight on its top should have reinforcing bars run close to the bottom. A concrete post when subjected to a pull at right angles will tend to crack at or near the ground line on the opposite side from the direction of the pull. Since pull or stress on a post may come from any direction, the post must be reinforced to withstand pull or shock from any direction. Not less than about three pounds of steel or iron rods are necessary for each post. Old fencing is sometimes suggested for this purpose but is practically worthless because of weakness and difficulty of placing properly in the concrete. Clean sand and gravel must be used, and care should be taken to see that it is properly graded as hereinafter suggested.

Forms. A variety of forms can be used. It is believed this method of construction insures a good post with a minimum amount of labor and number of forms. It is also desirable to have some means of holding the reinforcement in place while the concrete is being poured. An advantage in using metal molds is that the concrete can be placed wet enough to jar into place by lifting and dropping the ends of the forms a few times. Steel molds are also flexible enough to strip easily from the posts.

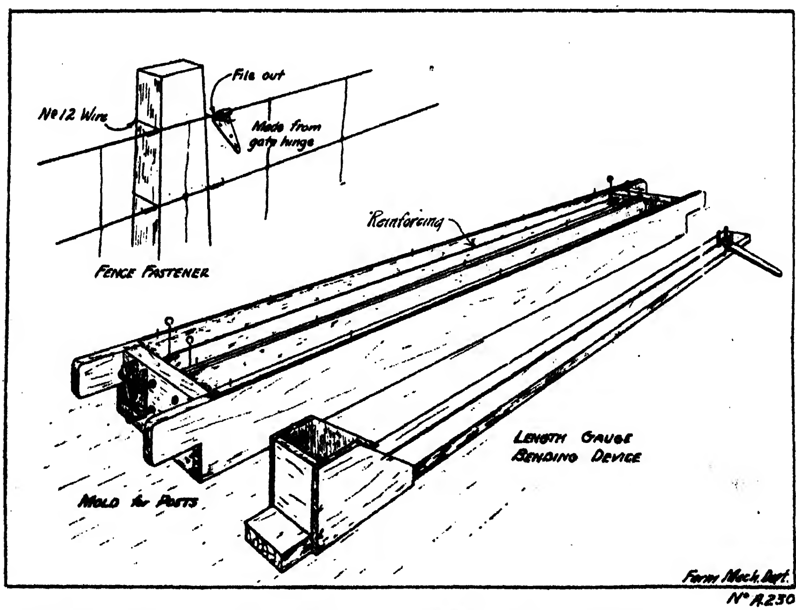

Fig. 3. Set up of forms ready for placing concrete. Reinforcing is held in place permitting forms to be jarred to settle concrete. Method of fastening line wires to post shown in upper left hand corner.

Cost. Cost will vary under different conditions. An estimate can be made by knowing that the cost of reinforcing of cement and aggregate, and of labor each constitutes approximately one-third of the entire cost. With steel for one post at 15 cents, the total cost should be in the neighborhood of 45 cents.

Concrete. The proportions of cement, sand and gravel to use should be 1:2:3; meaning 1 part cement, 2 parts sand, and 3 parts gravel. Sand is understood to be the material which will pass a screen of 1/4 inch mesh, and gravel that which will remain on it. For posts, however, gravel larger than 3/4 inch cannot well be used on account of the reinforcing, and it should be screened through a 1/2 or 3/4 inch screen. A mix made of these proportions, with sand and gravel measured separately, will generally make a better concrete than that made from gravel as it commonly runs at the pit. Pit gravel as a rule contains too much fine material. If pit gravel is used, it should be mixed 1:3, cement and gravel. For proportioning a bottomless box should be used for measuring the gravel. A bag of cement may be counted as a cubic foot and the box should be made large enough to hold gravel for a one bag mix. Where the sand and gravel are separate, the box should be made large enough to hold the gravel for a one or two bag mix, and the sand can then be measured in the same box.

Quantity of Materials. Each post will require a little less than a cubic foot of aggregate and approximately 1/4 of a bag of cement. A one bag mix of material will make 4 posts, and therefore two sets of forms will be needed. Also for a two bag mix, four sets of forms will be needed. With 4 sets of forms making 8 posts each 3 days, 16 posts per week can be made. Since but a short time is required to mix and place the material and reinforcing this should be carried along with other work. With this system a large number of posts can be made with a minimum expenditure for forms.

Reinforcing. Reinforcing should consist of 1/4 inch round smooth black iron or steel rods. Purchase these straight and cut to the required length,—8 ft. for an 8 ft. post. Hooks are then made on the ends of these rods with the bending device shown with the molds. The reinforcing rods should be placed one in each corner of the mold, and from 1/2 inch to 3/4 inch from the outside. If the mold is made with the end hole properly located, little attention will be required in spacing the reinforcing rods in the post.

Molds. The molds are made from galvanized iron and 1 inch boards. The metal part of the mold can be made by the local hardware dealer or blacksmith, or if the work is to be done on the farm the following directions will be of value:

1. Buy one sheet of 28 gauge galvanized iron of a length required for post. One sheet is sufficient to make one mold of two parts. As many molds may be made as desired.

2. Cut sheets lengthwise, a little diagonally, so that each piece will have a wide and narrow end, which, when bent, will give the proper size for the top and bottom of the post.

3. Lay one of the cut sheets on a bench and mark off the lines on which it is to be bent.

4. Lay over the cut sheet a straight board with its edge along the line to be bent and clamp or nail it to the bench at the ends.

5. Bend up sheet to a right angle along the edge of the board laid over the sheet. Make the rest of the bends on the same general plan, first clamping the metal between boards or plank. A bench vise or wood clamps may be used to clamp the boards together.

6. Build frame, as indicated on drawing, to a length to suit the metal molds.

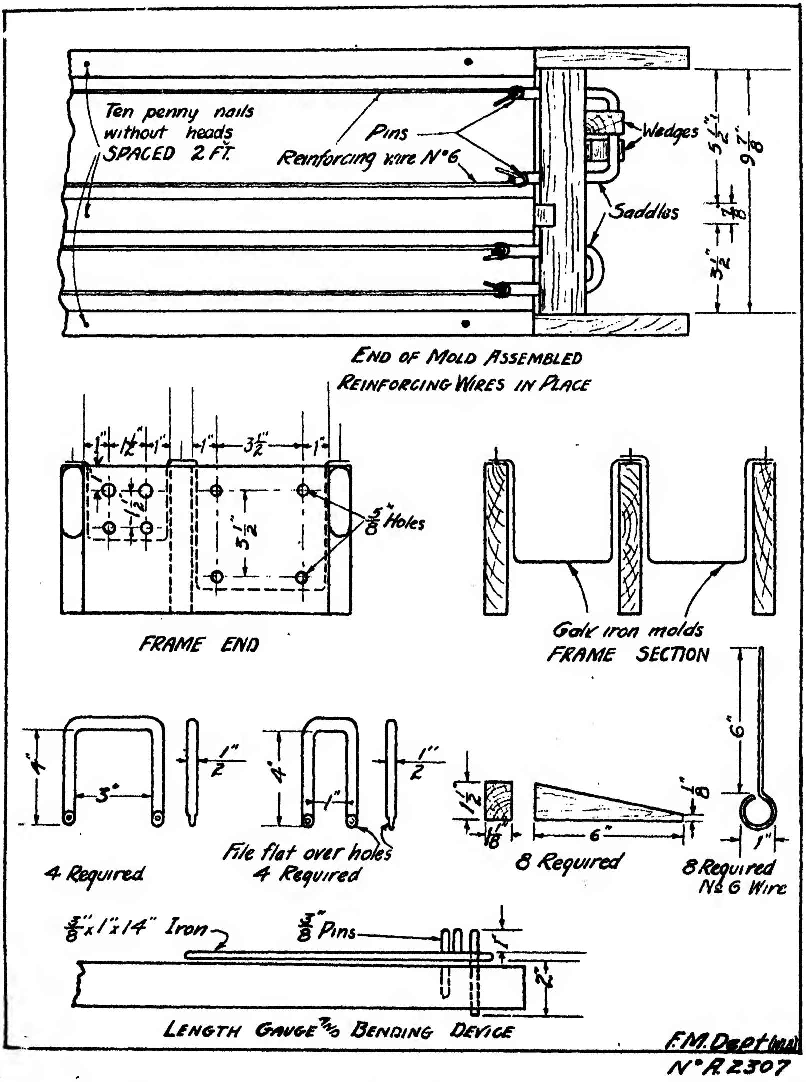

Fig. 4. Details and dimensions for constructing line post molds, also one end of assembly. Details for making holes for saddles must be carefully followed.

7. Square ends of sheets to fit frame.
8. Fit molds in frame and drive nails through sheets to support them. Remove mold and enlarge nail holes to make them easily removable.
9. Make saddles, pins, and bending device as shown on drawing.

Making Posts. Make enough molds to contain at least one bag mix at one time. Follow this order in making up the post:

1. Set up the bending device and make hooks on each end of rods, turning back about 1 inch of the rods. Make hooks on the same side of rod. Make hooks on all the rods first at one end, then use length gauge so that when the second hook is put on, all the rods will be same length.
2. Set up frame and hang galvanized iron molds in place. Insert saddles and set pins through the holes in the saddles.
3. Place reinforcing rods in each mold hooking each end over a pin inserted into the holes in the saddles. There should then be a rod in each corner of the mold with the hooks turned in.
4. Insert one wedge under each saddle and drive in until reinforcing rods are drawn tight and in place.
5. Mix aggregate, as directed under concrete, to a slush consistency and place in molds, jarring molds by lifting slightly and dropping while filling to compact aggregate. This will make the surface in contact with the metal smooth, and bring excess water to the surface.
6. Level off surface of concrete with board or trowel.
7. Remove wedges, pins, and saddles, and tuck down concrete at end of post.
8. Allow posts to set for 3 days, turn molds over carefully on a bed of sand, remove frame, and strip molds from posts. Cover posts with wet sand and leave for a period of 30 days.

Fastening Line Wires. Fence fastenings consisting of No. 12 wires passed around post with each end wrapped about the line wire of the fence. This method is exactly the same as the method of wiring insulations in telephone construction. A drawing of this device accompanies directions. It may be made from an old 8 inch hinge or by the local blacksmith from stock iron.

GREENHOUSE INSECTS

"Greenhouse Insects" is the name of a recent publication by E. I. McDaniel of the Entomological Section of the Michigan Agricultural Experiment Station. This bulletin is listed as Special Bulletin No. 134, and may be secured free of charge upon request to R. S. Shaw, Director of this Station.

This bulletin contains very valuable information in the methods of control and the description of the greenhouse insects which are of most importance to the Michigan greenhouse industry. Under methods of control, contact poisons, stomach poisons, fumigation, and soil sterilization are discussed. The description of, and the methods of control of over thirty-six insects are given in this publication.

FRUIT SETTING IN THE J. H: HALE PEACH

The Inter-Planting of this Variety with Some Other Variety Blossoming at the Same Time is Imperative

V. R. GARDNER AND STANLEY JOHNSTON, HORTICULTURAL SECTION

It is generally recognized by growers that certain fruit varieties are self-fruitful and certain others are self-unfruitful. That is, some are able to set and develop their fruit properly when planted in blocks by themselves; others develop their fruit properly only when cross pollination takes place. Among common deciduous fruits self-unfruitfulness was first demonstrated for certain strawberry varieties. Later certain varieties of grapes, apples, pears, plums and sweet cherries have been found to possess the same characteristics. Consequently, when setting any of these fruits the wise grower selects his varieties and plants with due reference to securing cross pollination. On the other hand it has been generally taken for granted that peaches, currants, gooseberries and certain other fruits are self-fruitful. Only within the last few years has fruit-setting loomed up as a serious problem in peach culture. As a matter of fact it has come to the front only since the introduction of the J. H. Hale variety.

The failure of this peach variety properly to set its fruit is accentuated in the mind of the grower by the fact that a large number of the blossoms which do not set, instead of falling off remain attached to the tree and develop into small rudimentary quarter — or third — sized peaches. To the grower it seems more like a problem in fruit development than in fruit setting and it is perhaps for this reason that growers generally have not associated the trouble with pollination. Instead, soil, pruning, cultural methods and the existence and propagation of degenerate strains have all been mentioned as causes of the trouble and remedies have been suggested accordingly.

Observations made by Connors (1) of the New Jersey Agricultural Experiment Station in 1922 have lead to the conclusion that under New Jersey conditions the J. H. Hale peach produces very little good pollen and that hence cross pollination is necessary if fruit is to set and mature properly.

The relatively high prices that first grade fruit of this variety commands, the acreage already planted and the demand for information on the part of peach growers generally, all combined to make desirable an investigation of the problem under Michigan conditions. Accordingly, arrangements were made with Floyd Barden of South Haven to place at the disposal of the Station for experimental purposes a block of approximately 175 five-year-old trees of this variety. These trees are located on a good site and soil and are in good vigorous condition, con-

1. Connors, C. H.—Proc. Am. Hort. Sci. 19:147-151. 1922.

sidering age and variety. A series of pruning and fertilizer experiments designed to throw light on the influence of various nutritive conditions within the tree on fruit setting and development were started in the spring of 1924. In addition, a number of controlled hand pollinations were made to determine to what extent the variety is self-unfruitful and what other varieties are most likely to prove satisfactory for cross pollination purposes. This is a preliminary report on the latter phase of the problem only.

The accompanying table summarizes the results of the controlled hand pollinations with the J. H. Hale (the usual technique being employed in collecting pollen, emasculating and bagging flowers, etc.).

TABLE I.—Showing Results of Pollination Experiments with the J. H. Hale Peach

	Number blossoms pollinated	Number fruits developed	Per cent blossoms developing fruit
J. H. Hale pollenized by J. H. Hale	1,471	0	0
J. H. Hale pollenized by Banner	176	68	38.6
J. H. Hale pollenized by Elberta	145	52	35.8
J. H. Hale pollenized by Kalamazoo	716	252	35.2
J. H. Hale pollenized by South Haven	483	169	34.9
Elberta pollenized by Elberta	117	45	38.5

The data, as presented in the table, are self-explanatory. Briefly, it may be stated that in this test J. H. Hale proved completely self-unfruitful, while Elberta, self pollinated for a check, set and developed 38 per cent of its blossoms. All four varieties used for cross pollination purposes proved satisfactory. As a matter of fact, there was little difference between them in the percentages of good normal fruits developing as a result of cross pollination. From this it might be inferred that all these varieties, and presumably many others, are to be regarded as equally satisfactory to interplant with J. H. Hale in order to provide for proper cross pollination. Such is not the case. A good pollenizer should not only furnish an abundance of compatible pollen but its blooming season should overlap that of the variety to be pollinated as completely as possible. Furthermore, it is desirable that it be a variety that itself is of high commercial value. Judged by these standards, the South Haven is the most satisfactory of the four varieties tried in this experiment, at least under Michigan conditions. Its blooming season is practically identical with that of J. H. Hale. No comment is necessary regarding its commercial value. Of the four varieties tried as pollenizers, Kalamazoo ranks as second best. It comes into full bloom a couple of days ahead of J. H. Hale but it still opens many blossoms during the flowering season of the latter variety. Elberta and Banner both blossom a little earlier than J. H. Hale and apparently shed a large percentage of their pollen early during their blossoming period. Consequently they are not to be regarded as entirely satisfactory for interplanting with this variety.

It should not be inferred from what has been stated that the interplanting of South Haven (or some other variety) and J. H. Hale will always insure a proper setting and development of the fruit of the

latter variety. Pollen of most tree fruits is dependent for its transfer from flower to flower and tree to tree on the work of certain insects, principally the honey bee. Those who grow this variety should make ample provision for cross pollination by establishing colonies of bees in or near their orchards.

Attention should also be called to the fact that occasional seasons even when ample provisions have been made for proper cross pollination, little cross pollination may actually occur. Cold, rainy weather during the blossoming season may both injure the pollen and interfere with the work of the bees. This is more likely to be the case with peaches than with apples, pears or certain other fruits which blossom a little later. Against these vagaries of the climate the grower has little protection or recourse. They must be accepted as one of the extra hazards that attend raising any variety that is self-unfruitful. On the other hand the results attending this investigation lead to the belief that J. H. Hale may be planted with confidence by Michigan growers who are willing to make the necessary provisions for proper cross pollination.

THE JAPANESE-BEETLE

R. H. PETTIT, ENTOMOLOGY SECTION

So much interest has recently been shown in the matter of the threatened establishment of the so-called Japanese-beetle in Michigan that a few words will be of more than passing interest. This creature originally came from the Orient some time prior to 1916, during which year it was discovered in New Jersey. The possibility of damage from this pest immediately became apparent, and from that time on both the New Jersey Department of Agriculture and the United States Department of Agriculture have exerted themselves in efforts to restrict the spread of the pest.

The culprit is a beetle about the size of a potato-beetle but colored a beautiful, bronzy green. The creature feeds in the adult condition on a long list of plants including: grape, raspberry, blackberry, apple, cherry, corn, soy-bean, red clover, rose, elm, the oaks, willow, smartweed, mallow, sassafras, elderberry, wild-cherry, and a host of other plants. So we see that the danger from the adult beetle alone caused directly by defoliation, is important. Furthermore, the larval condition or immature stages are passed underground, at which time the creature appears like a small grub. This white-grub resembles the common white-grub except in size, it being considerably smaller than the common species. Like the common white-grub, this particular pest feeds on the roots of plants. It develops one generation each year and the larvae or the pupa are in the soil practically the year round. During June the larvae change to pupae, and during late June and

July the beetles come out and shortly begin laying eggs for the next generation. The beetles then continue to feed through July and August at which time they destroy fruits and foilage in a wholesale manner. They feed on the surfaces of apples, peaches, and plums, and many of them collect on the tips of ears of corn, where they destroy the silk and the soft kernels. When they once become plentiful, the larvae are serious enemies of grass fields.

Fig. 5. Adult of the Japanese beetle.

The natural spread of the insect is about ten to fifteen miles a year, but occasionally individuals are carried to a distance where new infestations arise, and then, of course, the spread is much more rapid. It is not inconceivable that leaf-beetles or larvae may be transported from some place in Pennsylvania or New Jersey where the insect is at present established, and that Michigan will acquire this undesirable foreigner. There is even valid reason to suspect that the creature may be already in our state. Any suspected material which is sent to this office for identification should be enclosed in something absolutely unbreakable during transit. A tight, tin box carefully packed is pretty fairly safe, but it will be very much safer if the insects are first soaked in alcohol or formaldehyde in order to prevent the escape of the pest during transportation and its consequent introduction in the new territory. The control of this creature depends largely on arsenical sprays and the maintenance of a strict quarantine to prevent its establishment in new districts.

THE WEATHER AND MAPLE SUGAR PRODUCTION

Rainfall the Most Important Individual Factor in the Amount of Maple Sugar Produced

PAUL A. HERBERT, FORESTRY SECTION

Those familiar with the operation of a sugar bush know that the production of syrup or sugar varies considerably from year to year. Available records of the operation of the Michigan Agricultural College sugar bush from 1915 to date show a marked fluctuation in the syrup production per tree. The maximum yield secured (1915) was .295 gallons of syrup per tree. The minimum yield so far recorded that of 1923, was .129 gallons. "Sugar weather" is the usual explanation made for the variation in the same sugar bush from year to year.

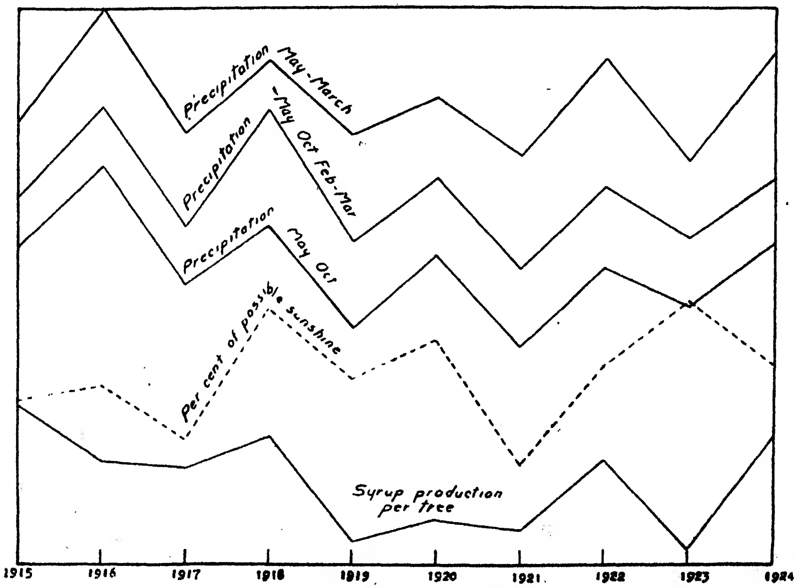

Fig. 6. A diagram which shows the influence of rain and sunshine on syrup production.

As there are a number of climatic factors that might possibly influence sugar production, a study of each factor was made covering the same years that there were sugar records available, that is, from 1915 to 1924. A graph of the syrup production per tree per year was first plotted as shown by the lower line in the accompanying illustra-

tion, and this was compared with curves of the climatic factors in an effort to show similarity between the two. In the accompanying diagram, in order to avoid confusion only those curves which showed a fair degree of correlation have been plotted.

It is a generally observed fact that the sap flow day by day varies with temperature and sunlight. Freezing nights and thaws accompanied by bright sunlight are generally considered to produce the greatest sap flow (1) (2). A study of the percentage of sunshine for the months of March and April (which are the months during which the sugar operations are conducted here) as compared to the total amount possible showed generally the same trend as the syrup production curve. Curves of air pressure, cloudy and clear days, difference between maximum and minimum temperatures, mean maximum, and minimum temperatures and rainfall, however, show no marked correlation when taken for the entire two months of March and April. The lack of correlation here in some of the temperature curves, which seems apparent to the casual observer, is doubtlessly due to the fact that the sugar season does not run the entire period and that the extreme climatic conditions occurring on both ends of the period so influence the average monthly figure that no correlation can be observed. This also perhaps explains the irregularities in the percentage of sunshine curve. "Sugar snows" often reputed to be beneficial could not be separated from precipitation for which no correlation could be shown. No daily records of sugar production are available and so daily weather comparisons could not be made.

The second problem was an attempt to show correlation between the weather during the previous growing season and the sugar production the following spring, on the theory that during a poor growing season less sugar is manufactured and stored over winter. The data studied in this problem included the months from May to October. The amount of sunlight during this period does not apparently influence the sugar curve. All temperature curves also seem without direct individual bearing on the sugar production. This leads to the supposition that other climatic factors being normal there is always sufficient heat and sunlight present during the growing season to produce the maximum amount of sugar obtainable.

The following diagram shows that a striking correlation is secured by plotting the amount of rainfall for these months. Apparently, the greater the rainfall during the growing season, the greater the sugar production the following spring. The only irregularity appears in 1915.

What effect has the amount of precipitation during the winter on the sugar production? No correlation is apparent for the early winter months. The precipitation record from January through March seems to follow the sugar curve fairly closely. The sum of the precipitation during the growing season and just preceding the sugar season seems to be the individual controlling factor in amount of sugar obtainable. Doubtlessly, the complex of factors here mentioned which do not singly seem to affect sugar production still influence it indirectly. Studies

(1) Bryan, A. H. and Hubbard, W. F.—The production of maple sirup and sugar. Farmers Bulletin 516, U. S. Department of Agriculture, Reprint, April, 1918.

(2) Jones, C. H., Edson, A. W. and Morse, W. J.—The Maple sap flow. Vermont Agr'l. Experiment Station Bulletin No. 103, 1903.

are planned to secure more definite information on the influence of factors of weather conditions during the sugaring season.

Maple sugar production has not received the attention it should in Michigan. Sugaring time comes at a season when many farmers are at leisure to earn the extra dividends that the sugar bush will produce. It has been found a paying proposition in New York where the average cost is $1.34 per gallon including all charges, labor, taxes, interest, equipment, etc. This year the Forestry Department of the College is attempting to secure data to determine average costs of maple sugar production in Michigan. Makers of syrup and sugar are urged to cooperate by sending for blanks upon which to keep cost records during the coming season.

BUTTERNUT PRODUCES "MAPLE" SYRUP

The Sap Flow of Butternut Only Slightly Lower Than Sugar Maple in Quantity and Quality

PAUL A. HERBERT, FORESTRY SECTION

Maple sugar of today is produced entirely from maple trees. It is not generally known that other trees such as butternut and walnut produce sweet sap which will make a good quality syrup. The sap flow from walnut is very small, but tests made on butternut (Juglans cinerea) during the last two sugar seasons showed a sap flow of only 6 per cent less than that of maples of the same diameter and crown development. Butternut sap begins to run a few days before sugar maple and continues at a fairly uniform rate throughout the sugaring season. Fluctuations in daily production due to weather conditions are not as marked in butternut as in sugar maple.

In boiling down butternut sap two distinct products are secured. Soon after boiling a considerable amount of jelly will float to the top of the pans. This jelly is made up largely of water, a little sugar, and a minute quantity of pectin. Six quarts of sap will produce three ounces of jelly. This jelly is nearly tasteless and must be removed if clear syrup is desired or sugar is to be made. It can be removed by skimming or straining.

The amount of sugar contained in butternut sap is only a little less than that found in sugar maple. Samples tested last spring by Professor C. D. Ball, Jr., of the M. A. C. Chemistry Department, analyzed as follows:

	Percent invert sugar (glucose and fructose)	Percent Sucrose
Butternut sap	0.26	2.10
Sugar maple sap	0.11	2.61

Butternut syrup has the same "maple" flavor found in the sugar maple syrup. Butternut, however, because of the prevalence of the Melanconis disease (Melanconis juglandis, Graves.) which materially shortens its life span, can in no sense take the place of sugar and black maple as the premier producers of maple syrup and sugar.

*THE VACCINAL IMMUNIZATION OF GUINEA PIGS

Against Bacterium abortus (Bang) Infection

I. FOREST HUDDLESON, BACTERIOLOGICAL SECTION

The virulence of *Bacterium Abortus* for guinea pigs and the characteristic gross and histo-pathological changes resulting from infection have remained established since the original discovery and description by Fabyan.

The possibility of developing an immunity against natural infection thus preventing the characteristic histo-pathological changes has been in the minds of many investigators, but little has been accomplished toward the protection of the guinea pig against this disease. The

*Research Associate Huddleson has shown in this abortion paper that guinea pigs can be protected against a virulent cattle germ by previous treatment with a living non-virulent culture (vaccine).

Michigan Technical Bulletin No. 65, by Mr. Huddleson, gives similar encouraging results of preliminary experiments on cattle using this same vaccine. Anyone interested in this bulletin may secure a copy upon request to R. S. Shaw, Director, East Lansing, Michigan.

This article reports the results of an experiment which is but a portion of the main project on "Infectious Abortion in Cattle" carried on co-operatively by the Sections of Bacteriology and Animal Pathology of this station. The Michigan Station has been conducting investigations on this disease since 1908. Substantial progress has been made during this time, but much remains to be done in the study of this most serious cattle disease.

This report is printed in the Quarterly Bulletin in order that the readers may know of the work and progress of the Michigan Station on the infectious abortion disease in cattle.

Editors Note.

specific agent that will give protection to the guinea pig should have far reaching possibilities. It should suggest the course to be pursued in the development of a preventative for the disease in the bovine.

The investigations of Stafseth established the impossibility of depending upon a killed vaccine (bacterin) for this purpose. These findings were later confirmed by Hagan who also showed that such an agent would not even protect guinea pigs against a minute dose of a living virulent culture. The writer had the same results in similar experiments in 1922. The worthlessness of a killed vaccine in protecting the guinea pig against the abortion disease should furnish considerable enlightenment on the same agent now being advocated for use in the bovine by some of our prominent biological manufactures.

It appears that when the viability of *Bacterium abortus* is destroyed by physical or chemical agents, there is also destroyed that property which is necessary in the development of a protective immunity in the animal whether it be guinea pig or cow. This statement is not a theory but, as will presently be shown a fact on which there is an increasing amount of evidence.

In the latter part of the year of 1920 the writer became aware that there were amongst the large number of strains of *Bacterium abortus* in this laboratory, strains which appeared to be non-virulent, strains on the border line, and strains distinctly virulent for guinea pigs. One of the non-virulent strains was selected for further study with the possibility in mind of developing it into an agent which would give a protective immunity to guinea pigs and cattle against Bang's abortion disease.

Up to the present time more than one hundred guinea pigs, both male and female, pregnant and non-pregnant have received a suspension of this organism in the viable state, intraperitoneally, intramusclarly, subcutaneously and orally without having produced a single visible lesion in their organs when killed after a lapse of from four to eight weeks. Furthermore the organism could not be cultured from any of the organs or body fluids by proved methods of isolation.

The titer of serum, antibodies (agglutinins and complement fixing) was, with few exceptions, low.

Since all animal inoculations have demonstrated the culture to be non-virulent and further, experiments designed to restore its virulence having failed to accomplish their purpose, it seemed reasonable to believe that there was a possibility of this living culture serving as an immunizing agent against a virulent strain of *Bacterium abortus*.

A preliminary experiment was started Jan. 18, 1923 with that purpose in view. At this time five female pigs were given a subcutaneous injection in the abdominal region of 0.5 c. c. of a turbidity 5 (McFarland's nephelometer) of a living suspension of the non-virulent culture of *Bacterium abortus*. After a lapse of twenty days they were fed daily for ten days in the feed, three, forty-eight hour agar slants of a virulent strain of *Bacterium abortus*.

The pigs were autopsied April 9, 1923. There was no macroscopic evidence of infection in the organs nor was *Bacterium abortus* cultured therefrom. The value of this preliminary experiment is limited owing to the failure to introduce control pigs during the exposure to infection.

A similar experiment was repeated May 24, 1923 using ten female

pigs and three controls. The immunization and exposure were prepared in the same manner as in the first series. The pigs were autopsied September 4, 1923, or about nine weeks from the beginning of the experiment. The organs of the immunized pigs presented no macroscopic evidence of infection nor could *Bacterium abortus* be isolated therefrom. Of the control pigs, two presented no evidence of infection and one showed characteristic lesions in the spleen, liver and left costal cartilage from which *Bacterium abortus* was isolated in pure culture.

A third experiment of the same nature was started June 28, 1924 using ten male pigs and three controls. The dose of the vaccine and the manner of injection were the same as in the previous experiments. After a lapse of twenty days from the date of injection, the immunized pigs were fed daily for ten days, five, forty-eight hour agar slants of a virulent culture of *Bacterium abortus*. This culture was isolated from an aborted bovine fetus about the time the exposure to infection was begun. The three controls were fed one forty-eight hour agar slant of the same strain from July 21 to August 1, 1924.

The results obtained are sent forth in table I. The ten immunized pigs showed no evidence of infection or the presence of the organism in the tissues of the organs, while the three controls presented marked

TABLE I.—The Immunization of Guinea Pigs with a Non-Virulent Strain of Bacterium Abortus

Pig No.	Date of vaccine treatment	Dates of exposure	Date of autopsy	Anatomical changes	Cultural findings	Agglutination test Serum dilution			
						0.04	0.02	0.01	0.005
1042	6-28-24..	7-18-24 to 7-28-24.	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	+	+
1043	6-28-24..	7-18-24 to 7-28-24	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	+	−
1044	6-28-24..	7-18-24 to 7-28-24	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	+	−
1045	6-28-24..	7-18-24 to 7-28-24	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	+	−
1046	6-28-24..	7-18-24 to 7-28-24	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	+	+
1047	6-28-24..	7-18-24 to 7-28-24	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	+	+
1048	6-28-24..	7-18-24 to 7-28-24	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	+	−
1049	6-28-24..	7-18-24 to 7-28-24	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	+	+
1050	6-28-24..	7-18-24 to 7-28-24	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	−	−
1051	6-28-24..	7-28-24 to 7-28-24	9-3-24..	No lesions present..	*Bact. abortus* very active....	+	+	+	−
1066	Control...	7-21-24 to 8-1-24..	9-4-24..	Spleen enlarged 3 times. Many foci in spleen and liver.	*Bact. abortus* isolated from spleen, liver and kidneys	+	+	+	+
1067	Control...	7-21-24 to 8-1-24..	9-4-24..	Spleen enlarged 4 times necrotic fetus in right horn of uterus. Many foci in spleen and liver.	Some including right horn of uterus.	+	+	+	+
1068	Control...	7-21-24 to 8-1-24..	9-4-24..	Spleen enlarged 3 times. Many foci in liver and spleen.	Spleen, liver, kidneys showed *Bact. abortus*	+	+	+	+

\+ = Complete agglutination
− = No agglutination.

evidence of infection and *Bacterium abortus* was isolated from the diseased organs in pure culture.

All of the immunized pigs with the exception of No. 1047 showed from fifty to one hundred grams increased in weight during the experiment. The exception lost sixty grams in weight. All of the control showed a loss of from one hundred to two hundred grams in weight from the first date of infection to date of autopsy.

There is considerable evidence presented in the foregoing experiments to indicate that the non-virulent strain of *Bacterium abortus* on subcutaneous injection, stimulates immunity production to a sufficient degree to protect guinea pigs from an infection with a virulent culture of *Bacterium abortus.*

The duration of the immunity has not yet been determined. Experiments are now under way which, when completed will throw considerable light on this phase of the subject.

FERTILIZERS

What They are and How to Use Them

A bulletin of especial interest to all farmers in the state has recently been published by this institution. It is entitled "Fertilizers, What They Are and How to Use Them," and is edited by M. M. McCool and C. E. Millar of the Soils Section. This bulletin is listed under Special Bulletin No. 133. It may be secured free of cost upon application to R. S. Shaw, Director, East Lansing, Michigan.

The food elements required by plants, and the removal of plant food by crops are discussed in this bulletin. The particular effects of nitrogen, phosphoric acid, and potash on plant growth are also given. Other subjects discussed are: plant food elements carried by fertilizers, influence of fertilizers on soil acidity, method of application, loss of plant food elements by leaching, home mixing, and fertilization of pastures.

SEASONAL MANAGEMENT FOR COMMERCIAL APIARIES

A new bulletin, which will be of interest to every bee-keeper in the state, has been recently published by this station. R. H. Kelty of the Entomological Section is the author. This bulletin is entitled "Seasonal Management for Commercial Apiaries," and is listed as Special Bulletin No. 135.

This bulletin gives very definite information in regard to the three systems of manipulation which are admirably adapted to Michigan bee-keeping conditions, and which, if adopted, will increase the efficiency of many of the twelve thousand Michigan bee-keepers. The three systems described in the bulletin are known as the Demaree Plan, the Markham Plan, and the Miller Plan. Complete information is given in regard to the management of bees during the spring, during the main honey-flow, and in making preparations for winter storage. Queen rearing is also fully discussed.

A "Beekeeper's Guide for Seasonal Management" is also enclosed with this bulletin, as well as a "Swarming Trouble Chart." This bulletin is available free of charge to all who may desire to have a copy upon request to R. S. Shaw, Director, East Lansing, Michigan.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, East Lansing, Michigan.

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251 Insects of 1907.
258 Insects of Field Crops.
262 Suggestions on Planting an Orchard.
264 Second Report of Grade Dairy Herd.
267 Michigan Weeds (only to libraries and teachers).
273 Utilization of Muck Lands.
277 Studies in the Cost of Market Milk Production.
281 Trees, Shrubs and Plants for Farm and Home Planting.
284 Some Information and Suggestions Concerning the Use of Phosphorus.
286 Studies and Cost of Milk Production—No. 2.
289 Corn Growing in Michigan
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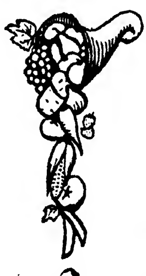

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R. S. SHAW AND E. B. HILL

CONTRIBUTIONS BY ALL SECTIONS OF THE EXPERIMENT STATION

MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN
VOL. 7, No. 3, February, 1925

ALFALFA AND HORSES

The results of one year's test show that alfalfa is a safe, efficient, and economical feed for work horses

R. S. HUDSON, FARM AND HORSE DEPARTMENT.

On December 2, 1923, nine teams of horses weighing from 1,430 to 2,000 pounds per horse, and ranging in age from two and one-half to fourteen years were selected for a year's feeding test. One horse of each team was fed corn and alfalfa and its mate received corn, oats, and timothy. This work continued for 13 weeks to March 2, 1924, when the results for the first or winter period were reported in "The Quarterly Bulletin," Volume 6 of May, 1924.

Fig. 1.—Team of three year old Percheron horses at work harvesting the corn crop on the college Farm at M. A. C. Jasper (Lot 1, fed corn, oats and timothy) and Dexter (Lot 2, fed corn and alfalfa) were two of the horses in the 1924 corn and alfalfa experiment. Jasper gained 10 pounds while Dexter gained 30 pounds during the summer months. During the fall test Jasper gained 40 pounds and Dexter 45 pounds.

At the close of the winter period the horses fed corn and alfalfa were changed to corn, oats and timothy, and the timothy fed horses were given corn and alfalfa to determine whether the individuality of the animals had anything to do with the results reported for the winter period. Two of the horses were sold, so that 16 of the 18 original horses con-

tinued in the test. The results of the first period (thirteen weeks-winter) and the second period (thirteen weeks-spring) were published in Michigan Circular Bulletin, No. 65, entitled "Alfalfa and Horses."

THIRD PERIOD—SUMMER

The same eight teams of horses weighing from 1,500 to 1,920 pounds and ranging in age from 3 to 15 years were continued in the test. The horse in each team receiving corn and alfalfa during the spring months, continued on corn and alfalfa during this and the following period, and its mate continued on corn, oats, and timothy.

No change was made in the feeding of the two groups at this time as was done at the end of the winter period, the idea being to determine if possible whether or not a long continued period of alfalfa feeding would in any way injure a horse.

The horses were weighed every two weeks. All feed was weighed and a record kept of the weights together with a record of the hours each horse worked. During most of the period they did farm work and general teaming that would class as medium to heavy work. The results given in the following table for the summer months do not look so well for corn and alfalfa as do the results reported for the winter and spring periods, in which the corn and alfalfa horses show a gain over the corn, oats, and timothy horses during the winter period, and a maintenance of weight during the spring months when the corn, oats, and timothy fed horses lost 570 pounds. The loss in weight for the corn and alfalfa fed horses is due to the reduction in weight of Kate, fed corn and alfalfa. Kate was so fat on June 8 that she did not breathe well. She was given less feed for the purpose of reducing her weight. A reduction of 200 pounds enabled her to do much harder work greatly increasing her usefulness, but does not allow a showing in weight for the group of horses fed corn and alfalfa.

The results clearly indicate that horses may be fed corn and alfalfa during the hot summer months when they are cultivating corn, harvesting grain and hay crops, and that they will do their work as efficiently, and maintain their health and vigor as well as when fed a more costly ration of corn, oats and timothy.

During the spring period the cost of feed for the corn and alfalfa fed horses still remained low as compared with that for the corn, oats and timothy horses.

During the period Tony, Daisy, Jasper and Dexter were exhibited at two county fairs. This reduced the number of days worked by these particular animals but made it that much more difficult to maintain their weight and health as they were on board cars four days of the time. None of them were sick or off feed which further demonstrates the value and safety of alfalfa and corn.

FOURTH PERIOD—FALL

The same animals, receiving the same feeds were continued in the test. Thè method of feeding, working, weighing and keeping records was the same as in the three previous periods. The work largely consisted of cutting and hauling the corn crop, doing fall plowing, and general team work on the road, all of which would rank as heavy work.

The result of the 4th period test (12 weeks) of the comparative feeding value of corn and alfalfa versus corn, oats, and timothy as shown in Table 1 indicates that horses doing fall work can be maintained in weight and at less cost per day when fed an alfalfa and corn ration in place of corn, oats, and timothy.

During this period two animals were sick. Tony, Daisy, Jasper, and Dexter were again exhibited at two Michigan Fairs. Tony had an attack of colic while on the train and the sickness continued throughout the first night after the animals landed at the fair grounds. Another horse, Duke, was sick one night during the period with an attack of impaction. This kept him from working for 6½ days. This, however, can hardly be charged entirely to the ration as Duke was the most delicate feeder of all the animals in the test. He never was a hearty feeder, always mincing his food, never licking his feed box and always taking much time in eating what food he did consume. It must be remembered that these two animals were the only ones sick throughout the entire year. Tony received corn, oats, and timothy during the last nine months of the test. Duke received corn and alfalfa during the last nine months of the test. Since one horse in each lot was sick it cannot be charged that alfalfa and corn are unsafe feeds.

SUMMARY OF HORSE FEEDING EXPERIMENT

December 1, 1923 to November 30, 1924

Table 1.—The following shows the result of one year's test in the comparative feeding value of corn and alfalfa versus corn, oats and timothy.

Corn, Oats and Timothy

Period	Days worked	Weight beginning	Weight close	Gain	Loss	Feed Consumed			Cost		
						Corn	Oats	Timothy	Total	Per day	Per hr. work
Winter	430	14,720	14,690	....	30	6,049	3,921	15,601	$279.70	$.341	$.081
Spring	492.5	14,300	13,730	....	570	6,305	4,362	14,759	266 71	.366	.075
Summer	538.5	13,730	13,770	40	....	6,441	5,063	14,024	266 17	.365	.061
Fall	482	13,770	13,780	10	....	4,858	5,039	13,365	263 40	.391	.068
Total	1,943	56,520	55,970	....	....	23,653	18,385	57,759	$1075.98	$1.463	$.285
Average per horse	232	1,713	1,696	....	17	8.02	6.23	19.59	$.365	$.365	$.071

Table 1.—Continued.

Corn and Alfalfa

Period	Days worked	Weight beginning	Weight close	Gain	Loss	Feed consumed		Cost		
						Corn	Alfalfa	Total	Per day	Per hr. work
Winter....	472	15,310	16,030	720	....	9,091	12,066	$243 50	$.297	$.064
Spring....	469	13,330	13,310	....	20	9,454	12,535	227 99	.313	.060
Summer...	553	13,310	13,200	....	110	10,375	14,573	235 75	.323	.053
Fall.......	463	13,200	13,315	115	....	7,148	13,608	207 47	.308	.056
Total...	1,957	55,150	55,855	....	....	36,068	52,782	$914 71	$1.241	.233
						Lbs. per day	Lbs. per day			
Average per horse.	236	1,671	1,692	21	....	12.23	17.91	$.31	$.31	$.058

Cost Basis

	Corn	Oats	Alfalfa	Timothy
Winter........	$.383	$.506	$23 00	$18 66
Spring........	.38	.48	20 00	18 00
Summer........	.55	.60	10 00	10 00
Fall........	.60	.55	12 50	14 00

From the data presented in Table 1, it will be noticed that the alfalfa fed horses worked on an average of 236 days out of a possible 300, while the timothy fed horses averaged 232 days out of 300.

The alfalfa fed horses made an average gain of 21 pounds each for the year while the timothy fed horses lost an average of 17 pounds per head for the year.

The alfalfa fed horses consumed an average of 12.23 pounds of corn and 17.91 pounds of alfalfa while the timothy horses consumed more grain and hay, eating 8.02 pounds of corn and 6.23 pounds of oats with 19.59 pounds of timothy on the average per day.

It cost 31c per day for feed or 6c for an hour of work with the alfalfa horses and 37c for feed or 7c for an hour of work with the timothy fed horses.

From a theoretical standpoint a ration made up of 12.23 pounds of corn and 17.91 pounds of alfalfa for a 1,670 pound horse at medium to heavy work, carries a high percentage of protein and is lacking in dry matter. It seems that the ration could be somewhat improved from this standpoint by substituting some timothy or oat straw in place of a part of the alfalfa. The substitution of oat straw would somewhat reduce the cost.

Conclusion

The alfalfa acreage in Michigan and throughout the United States is continuously on the increase as crop statistics show, and the demand for alfalfa is also on the increase as feeders become more acquainted with its use.

Use of the horse in cities on short hauls such as milk delivery, ice delivery and kindred services continues to increase so that the larger cities are now bidding for hay.

Results reported in this article show that horses fed alfalfa and corn for one year, easily maintained their weight and health, and efficiently did just as much work of various kinds and at less cost than their team mates eating corn, oats, and timothy. This test should not only help to overcome some of the suspicion which farmers have had toward alfalfa as a feed for farm horses but should assist in increasing the demand and price for this feed in the city.

THE 1925 WOOL CLIP

Care should be Taken to Produce a Good Fleece and to Prepare it Properly for Sale

G. A. BROWN ANIMAL HUSBANDRY SECTION.

The success of the 1924 wool pool should induce every Michigan wool grower to put forth his best efforts to turn out a clip of maximum value in 1925. Under the old method of lumping off the entire clip at so much per pound to a local dealer who perhaps paid the same price for all clips in his territory regardless of the quality, condition, or intrinsic value there was little inducement for the individual grower to improve his clip. Growers who pooled their wool in 1924 received more for it than they would have obtained had they sold to local dealers at the time of pooling, and what is more, every fleece was paid for on the basis of its actual value. Under these marketing conditions the wool grower is well repaid for any effort put forth to improve his clip and market it in a more attractive form.

Much can be done between now and shearing time to improve the quality of a clip. The first precaution to be taken is to see that the flock is in a healthy, thrifty condition. If the least symptoms of parasites are apparent the flock should be drenched with copper-sulphate as soon as possible. This is always a good precaution to take sometime during the winter.

The quantity and quality of the wool clipped also depends to a considerable extent upon the way in which the sheep are fed. Sheep which are poorly nourished cannot produce a good quality of wool. The ration

by all means should contain some leguminous hay such as clover or alfalfa, and preferably a succulent feed, such as corn silage or roots. Where the flock is in thin condition, the feeding of some grain is advisable.

Protection from inclement weather and storms also means a somewhat greater yield of wool and staple of better quality than where the sheep are compelled to endure exposure to all sorts of weather conditions.

The sheep racks and sheep sheds should be so constructed that the fleece is kept especially clean and free from any foreign matter such as chaff, straw, etc.

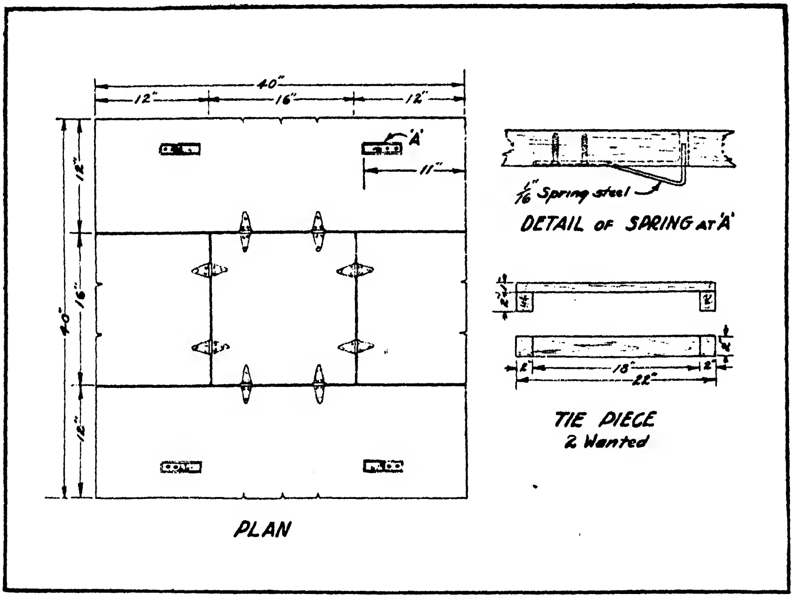


Fig. 2.—Michigan wool is often tied too tightly, thus reducing its sale value. This is generally due to the usė of too small a wool box.

Frequent tagging or removal of all soiled parts from the dock will prevent the soiling of an increasing amount of wool as the fleece becomes longer. At shearing time, the sheep should be absolutely dry and sheared in a clean place. All soiled parts of the fleece being removed, likewise brush off all straw and hay which might be clinging to the under parts of the sheep. In shearing, pains should be taken to keep the entire fleece together in so far as possible and fold it so the outside surface of the fleece will be in the inside, thus making a clean white package. The appearance of the package has much to do with the grading. A fleece poorly tied with an excess of twine is always objectionable. Nothing but the best quality of paper or hard hemp twine should be used *and care should be taken not to tie the fleece too*

tight. A fleece closely tied gives the impression of being especially heavy which leads the grader to think that it contains an excessive amount of oil and will, therefore, shrink a very high percentage. The statement has been made by wool graders that Michigan farmers would obtain considerably more for their wool if they would do it up in larger packages and use less string. It is also said that Michigan wool is tied much tighter than that from adjoining states.

A diagram of a wool box accompanies this article. This box is 16 inches square on the bottom and 12 inches high. A box of this kind makes the fleece appear larger than if it was tied up in a perfectly square box or one that was 12 inches square and also 12 inches deep. Where a clip of wool does not average more than 8 pounds in weight per fleece a wool tying box 14 inches square and 12 inches deep is about the right size. Where fleeces average over 10 pounds in weight it is desirable to use a box 16 inches square and 12 inches deep.

REARING EARLY CHICKS

Direct Sunlight and a Suitable Ration are Necessary to Grow Early Chicks Properly

C. G. CARD, POULTRY SECTION.

There has been an increased interest lately, in the problems involved in feeding young chickens. A number of investigators have been experimenting with chickens reared indoors, under artificial conditions, and the result of their work has great value for poultrymen who must hatch and feed chickens at seasons when the young birds can not be sent out of doors. Their chief conclusion is that the problems of indoor rearing is very largely a problem in feeding. Almost everything of which the chick is deprived when kept indoors can be supplied to him in his ration.

Early broilers always sell at a high price because the available supply is less than the market demands. This is true because they are produced out of season, when all the operations attending their production are rendered more difficult and expensive than during the spring and summer months. Hatching eggs are scarce and high priced, and they are likely to be low in fertility and hatchability.

It requires ten to twelve weeks to grow broilers so they will average one and a half to two pounds, the weight that seems to be desired on the market. To obtain this weight at a time when the maximum price per pound is paid, means that the chicks must be hatched during the last half of January or the month of February. Eggs used for hatching purposes at this time of year, must be gathered often, otherwise many may be chilled and the germ killed. No eggs should be set which are more than twelve or fourteen days old. The fresher the eggs, the better they should hatch.

Chicks are hatched at a temperature of 103 degrees F., and for the first four or five weeks after hatching warmth is one of the most essential requirements. Perfectly hatched chicks plus perfect rations will not insure success, unless the temperature conditions are satisfactory for the comfort of the chick. The brooder stove should be regulated for several days so that it will maintain a temperature of 90 degrees F. when the bulb of the thermometer is placed on the floor at the outer edge of the hover.

The floor of the brooder house should be covered with litter of cut straw, shavings, alfalfa leaves or similar material, to a depth of one inch. Placing an inch or two of sand on the floor is often helpful in early season brooding, in holding the temperature more uniform, and will also make the cleaning of the house somewhat easier.

The chief differences in the diet and environmental conditions of the indoor as contrasted with the out-of-door chicks, as usually fed, consist in the food which the out-of-door chick finds for itself (greens, roughage, dirt, bugs, etc.), the greater amount of direct sunlight to which it is exposed, and the greater opportunities for exercise which it has.

Experiments by Halpin at the University of Wisconsin, Card, University of Illinois, and others, show that the first two factors i. e., elements in natural food, and sunlight, are the chief causes of the superiority and better growth of the out-of-door chicken. When these are supplied to chicks growing indoors, they can be reared to maturity with no more exercise than that allowed in an enclosure providing one to two sq. ft. of floor space per bird.

The problem of the man who produces early broilers or who must rear chicks in confinement is to find out and then to supply the necessary food elements of which the indoor chick is usually deprived.

The old viewpoint on animal feeding, emphasized only heat and total protein as the necessary factors. The modern view is that a ration to be adequate for growth and reproduction, must contain an abundance of heat (digestible carbohydrates and fats), proteins of the right quality, a suitable mineral mixture, some ballast or indigestible material, and in addition, the vitamines.

A practical ration meeting these requirements, has been prepared by Halpin at the Wisconsin College of Agriculture, and has given unusually excellent and uniform results. This ration consists of 80 parts of yellow corn, 20 parts of wheat middlings, 5 parts of raw bone, (about 50 per cent calcium phosphate), 5 parts of pearl grit (calcium carbonate), 1 part of common salt, and skimmed milk used freely. This ration is fed as a dry mash with the milk as a drink. No water is allowed. Without the water allowance, a more generous amount of skimmed milk will be consumed. There is no scratch feed or green feed provided.

Direct sunlight plays an important part in animal life, including the chicken. The rays that are effective in the prevention of rickets are those of short wave length. Ordinary window glass absorbs these rays and consequently a room well lighted through ordinary windows is about as effective as an underground cellar so far as its ability to prevent rickets is concerned. It is the direct sunlight of the out-doors and not the fresh ground or green grass that are the effective preventatives of leg weakness in chickens. The above ration plus direct sunlight is a

complete ration for chick rearing. It needs no further supplement, not even eggs, cod liver oil, or green material.

THE NEW POULTRY DISEASE

A Description of Symptoms, Lesions, Diagnosis and Prevention of a Poultry Disease Similar to or Identical with European Fowl Plague

H. J. STAFSETH, BACTERIOLOGICAL SECTION.

In October, 1924, a disease similar to or identical with European fowl plague was discovered in New York and Pennsylvania. Shortly afterward this disease was found in one or two other eastern states. About the middle of January 1925, the Bureau of Animal Industry, Washington, D. C., the Department of Agriculture, Lansing, Michigan, and the Department of Bacteriology, Michigan Agricultural College, examined tissues submitted by poultry markets in Detroit, Michigan. Reports were returned almost simultaneously from all three laboratories that fowl plague or a very similar ailment had been found. Thus a new disease is added to our already long list of well recognized poultry maladies. How long this disease has been present in the flocks of our state and how widely it has spread is not known. Neither do we know what economic significance it will have. If this disease is a recent arrival, we may have reason to fear its presence, because our flocks are then very likely highly susceptible due to a possible lack of acquired immunity which usually results from continued exposure to certain infections. For this reason it is well to avoid an undue amount of communication between flocks until we know a little more about the true status of affairs. Diseases found in certain poultry shows and markets one year ago correspond as far as symptoms and tissue changes are concerned, exactly to those found in the present outbreak. For some reason incentive seemed to be lacking for a serious attempt at uncovering the cause of the trouble until this year.

Symptoms

In some cases birds may die without exhibiting appreciable signs of disease. At other times droppiness and inappetence are observed, the bird sitting around with drooping tail and head and closed eyes. Occasionally, birds affected in this way will raise their heads but they soon go back into a somnolent condition, perhaps after shaking the head a few times, an act which often causes them to stagger and fall. A watery or mucous discharge from the nostrils and eyes may appear in the early stages and continue throughout the course of the disease. Swelling of the tissues around the eyes, edema (swelling) of the wattles and of the tissues in the intermandibular space may also be observed in cer-

tain cases. Quivering has been seen in the early stages of experimentally infected birds. One of the early symptoms is ruffling of the feathers especially in the back of the neck. Coughing, shaking of the head, gasping for breath and rattling sounds in the throat are symptoms particularly evident in more chronic cases. Pneumonia may result in some instances. The disease usually runs a rapid course and has a short incubation period. Some of our experimental birds have shown symptoms less than twenty-four hours after inoculation, and one bird died thirty-one hours after intramuscular infection while some died in sixty-nine hours.

Lesions

While lesions may vary from no appreciable tissue changes to rather extensive alterations in many parts of the body, the most common features noted are hemorrhages (red spots) of pinpoint or pinhead sizes in the larnyx, trachea, serous membranes of thorax and abdomen, fat of the heart, gizzard, proventriculus, mesentery, muscles, mucous membrane of the proventriculus and intestines. Various quantities of serous exudate in either liquid or coagulated form may be found in the pericardial sac. In one case edema or swelling of the wattles was observed, and, in removing the wattle, it was found to contain a large quantity of gelatinous fluid. In the space between the mandibles, a large gelatinous mass was found causing a puffy swelling of the throat. The vessels of the ovary are often heavily injected with blood giving this organ a very dark or bright red color.

Diagnosis

As the disease is caused by an organism which has so far never been cultivated and is too small to be seen under the microscope and as the symptoms and lesions described may occur in other septicemic diseases of poultry, animal inoculation remains as the only reliable method of diagnosis. Rabbits as well as chickens are susceptible to the common poultry diseases which epidemiologically, symptomatically and pathologically resemble fowl plague. Rabbits and guinea pigs are resistant to the virus of the latter. This fact and the filtrability of the causative organism through filters which will retain most disease producing bacteria of poultry give us a basis for a differential diagnosis.

Prevention

No successful treatment or method of immunization is known. The virus is spread through the various body discharges. For this reason one must isolate or better kill and burn all affected birds as soon as possible and remove healthy birds to uninfected premises. Enough potassium permanganate should be put in the drinking water to give it a deep port-wine color and frequent changing is essential. Since feed as well as water may become contaminated quite easily, it may be well to protect the feed by using such hoppers as will protect it against gross contamination. Daily cleaning of the house followed by thorough disinfection should be practiced until it is felt that the outbreak is over. Sub-

dividing the flock into small units and keeping them in reasonably close confinement will facilitate inspection and prevent wide dissemination of the virus, thus aiding the control in general. Three to five per cent solutions of most of the coal tar disinfectants are very effective.

SPRING FERTILIZATION OF FALL SEEDED GRAINS

Nitrate of Soda and Sulphate of Ammonia have produced a twenty-nine percent Increase in Yield of Grain on the Lighter Types of Soil

G. M. GRANTHAM, SOILS SECTION.

Fall seeded grains on the sandy loams or the lighter types of soil which are of medium to low productivity, usually respond well to spring applications of nitrogenous fertilizer or manures. In the early spring when the young plants are starting to grow, an ample supply of nitrates are necessary for the maximum development of the plants. On these soils of medium to low productivity the growth of plants seems to indicate an insufficient amount of nitrates during early development and as a result the plants are stunted, a handicap they never overcome. After a severe winter and spring, the wheat and rye plants are forced not only to start growth in a weakened condition but to withstand undernourishment at a critical stage of development.

With the dry fall of 1924 and the resulting late start of wheat and rye coupled with a probable injury by ice during the early winter it seems that a special effort to overcome these handicaps could be economically practiced this spring.

Applications of fertilizing materials should be made about the time the plants start growth in the spring. If machinery is used to make the application, the ground should be firm or application should be made during a time of the day when the ground is frozen.

Barnyard manure applied at the rate of four to eight loads to the acre should give good returns. On the Cass County Experimental field located on a sandy loam soil of low productivity, top dressing applications of manure at the rate of eight tons per acre have given, as an average for four years, 65 per cent increase in small grains over a similar piece of land receiving no manure. This large percentage of increase, which was obtained from one field, is probably due to the residual effects of the manures. Over a number of different types of the lighter soils it is doubtful if this large percentage of increase could be maintained.

Nitrate of soda at the rate of 60 to 100 pounds per acre, or sulphate of ammonia at the rate of 40 to 75 pounds per acre used as a top dressing has proved profitable on a number of experimental fields. To secure the best results from sulphate of ammonia it should be applied to land which is not sour. As an average of a number of trials on several different

types of soil, ranging from sandy loam to sands, nitrate of soda and sulphate of ammonia have given a 29 per cent increase in yield of small grain over a similar piece of land not receiving these fertilizers. The applications of nitrate of soda and sulphate of ammonia are usually made by broadcasting by hand inasmuch as there are few, if any, mechanical spreaders that will accurately apply so small an amount. If

Fig. 3—Wheat from Cass County Field.
Right—No treatment—Yield 8.26 bu.
Left—100 lbs. Nitrate of Soda—Yield 15.73 bu.

the bags of fertilizer can be distributed over the field so that the broadcaster will not be forced to carry excessive loads of fertilizer, one man will have no trouble in covering 15 to 20 acres per day. If a day can be chosen when the humidity is low and only a moderate wind blowing, the disagreeable part of broadcasting can be avoided to a great extent.

SUGAR BEET FERTILIZATION

The Use of Phosphate has Given the Greatest Returns

O. B. PRICE, SOILS SECTION.

There are but few farmers in Michigan who do not use fertilizers in growing sugar beets. Due to the great variety of analyses in use, the selection of the proper mixture is one of the most important considerations in fertilizing this crop.

Phosphoric acid,* the most important ingredient in mixed fertilizers, when compared with other fertilizing ingredients has produced the greatest increases in yield of beets. This is shown by the work of the Experiment Station in the over-state soil fertility tests.

Table 1.—Increase in yields of sugar beets due to increased applications of phosphoric acid

Fertilizer used	Rate	Pounds phosphoric* acid per acre	Yield per acre
3-8-6	400 lbs. per acre	32	9 tons, 1,392 lbs.
3-24-6	200 lbs. per acre	48	11 tons, 902 lbs.
3-30-6	200 lbs per acre	60	12 tons, 1,540 lbs.
0-45-0	142 lbs. per acre	64	12 tons, 1,339 lbs.
No fertilizer			9 tons, 647 lbs.

These results do not mean that phosphoric acid is the only ingredient to be considered, but it does show it is the most important.

The results from the use of potash are variable. While it is known that sugar beets contain a large percentage of potash, nevertheless the results obtained by experimental tests have shown that in many instances its use has not shown any increase in yield. Most of the sugar beets in these tests, however, were grown on the heavier types of soil where potash is not the limiting factor in crop production. The results from two series of experiments on Brookston silt-loam soil are shown in Table 2.

Table 2.—Yields resulting from increased applications of potash

Series 1.		Yield per acre	
No fertilizer		9 tons	647 lbs.
3-24-6	200 lbs. broadcast at planting	11 tons	902 lbs.
3-24-12	200 lbs. broadcast at planting	11 tons	464 lbs.
3-30-0	200 lbs. broadcast at planting	13 tons	341 lbs.
3-30-6	200 lbs. broadcast at planting	12 tons	1,540 lbs.

*Phosphoric acid is the main fertilizing material in acid phosphate, and bone-meal and rock phosphate. Sixteen per cent acid phosphate, for example, contains 16% available phosphoric acid.

Series 2.

No fertilizer	10 tons	1,901 lbs.
0-12-0 200 lbs. drilled with seed.............	11 tons	593 lbs.
0-12-6 200 lbs. drilled with seed.............	11 tons	985 lbs.
0-12-12 200 lbs. drilled with seed.............	11 tons	1,697 lbs.
0-12-24 200 lbs. drilled with seed.............	11 tons	878 lbs.

Results from nitrogen carriers are dependent largely on climatic conditions. If the spring is wet and cold then applications of an available form of nitrogen is essential. This should be applied broadcast at time of planting. Table 3 shows the results of applications of nitrogen through the growing season.

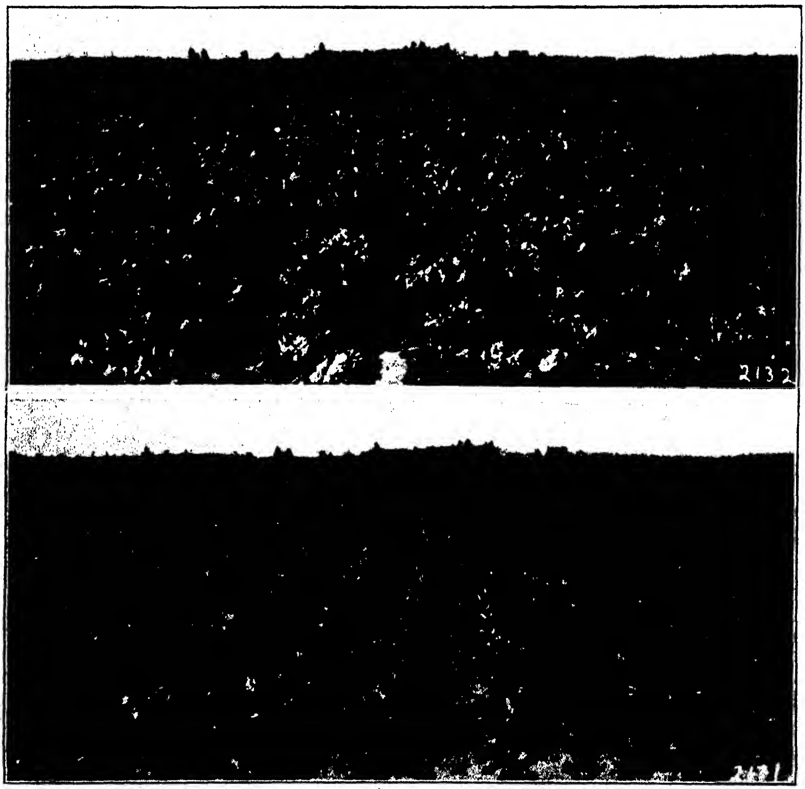


Fig. 4.—Above—Field of Sugar Beets in Huron County—No fertilizer used. Below—Adjoining field were 100 lbs. of Ammonium sulfate per acre was was drilled with the seed. Planted same time. Photographed August 11, 1924.

Table 3.—Yields resulting from applications of nitrogen throughout the season

*Treatment and rate per acre	Yield per acre	
No fertilizer	7 tons	1,610 lbs.
0-12-12 300 lbs. at planting	8 tons	1,937 lbs.
0-12-12 300 lbs. and sodium nitrate 150 lbs. at planting	11 tons	995 lbs.
0-12-12 300 lbs. and sodium nitrate 150 lbs. (½ at planting, ½ mid season)	10 tons	639 lbs.
0-12-12 300 lbs. and sodium nitrate 150 lbs. (⅓ at planting, ⅓ mid-season, ⅓ late summer)	8 tons	1,927 lbs.
Sodium nitrate alone 150 lbs. at planting	7 tons	1,465 lbs.

Caution should be observed in the use of the highly concentrated nitrogenous fertilizers. When applied with the drill in direct contact with the seed, serious injury to germination has resulted where used at the rate of 100 or more pounds per acre. The maximum rate of application without injury has not yet been determined but investigations are now in progress to determine the amount that can be safely applied. Applications as large as 300 pounds of sodium nitrate and 216 pounds of ammonium sulfate per acre, when used as a top dressing have not caused any injury. It is recommended that these highly concentrated materials be applied broadcast until investigations disclose the maximum amounts that can be used without injury to the seed. The accompanying pictures show the injury due to use of concentrated nitrogenous material with the seed.

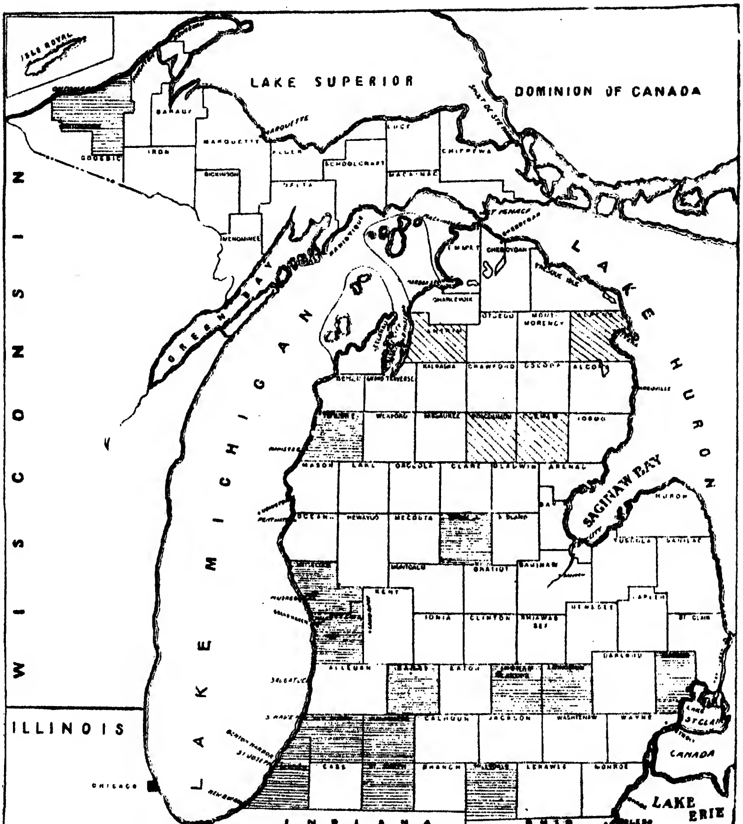
SOIL SURVEY WORK IN MICHIGAN

Valuable Information has been Secured in the Recent Survey of Eighteen Counties

M. M. MC COOL, SOILS SECTION

Ten years ago last summer the writer made a trip through Michigan to get a general idea of soil and agricultural conditions, so that an intelligent soils program for the State might be planned. As a result of those and subsequent observations, it was concluded that owing to the great diversity of soil and climatic conditions which occur in the State, precautions should be taken to avoid the accumulation of a mass of information that could not be correlated. In other words, the investigations on the property and needs of the soils in the State should be conducted systematically. It was stated, on several occasions, that if such were to be accomplished, it was essential that the soils should be classified. That is to say, a soils survey should be conducted along with other activities.

*All Fertilizers Broadcast.



Experiment Station, Michigan Agricultural College, U. S. Bureau of Soils, Co-operating.

Experiment Station, Michigan Agricultural College; U. S. Bureau of Soils; Conservation Department, State of Michigan, co-operating.

Fig. 5.—A map showing recent soil surveys made in Michigan. Farmers living in the counties should find them very useful in learning of the general lime and fertilizer requirements of their soils.

Shortly after the Soils Section was reorganized, it was "swamped" with requests for information on the best methods of managing the various soils. In order to meet this situation, reconnoissance or general surveys were made in southwestern Michigan by the writer and G. M. Grantham. Attention was called repeatedly to the low acreage of legumes, the great need for an increase in the organic matter content of most of the soils, and the general deficiency of lime and phosphorus. Information on the soils of other sections was collected in a similar manner.

In 1920 an agreement was entered into by the Michigan Agricultural Experiment Station and the United States Department of Agriculture,

Bureau of Soils, whereby a detailed soil survey of Michigan was to be completed, the expenses to be shared about equally by the co-operating organizations. In 1923 the Soils Section of the Michigan Experiment Station entered into an agreement with the State Conservation Department to co-operate in conducting the soil survey phase of the work.

Contributions of the Soil Survey

The soil survey has been of immediate and direct benefit in several ways to those who have seen fit to make use of the information that has been collected during its progress.

There is a general misunderstanding relative to what is meant by such terms as "sandy" soils, "loam" soils, "clay" soils and others. It is true that people classify various objects by comparison, for example, one who lives in a country where much of the land is very fine in texture or, using the popular term, "heavy," his conception of what is meant by a "sandy" soil may be and is different usually from that of a person who lives in a section or region in which sandy soils predominate. As a result, misunderstandings arise with respect to the classification, value, and methods of management of different soils. The soil survey has been directly responsible for an accurate and detailed description and classification of nearly all of the soil types that are present in the State of Michigan. There are no less than one dozen distinct sandy types of soil. These differ in topography, conditions of drainage, vegetable matter content, lime content, available fertility, nature of subsoils, water retaining capacity and consequently in agricultural value and methods of management, such as crop adaptation and fertilizer practices. The description and general location of these are given in Michigan Special Bulletin No. 128.

The other classes of soil,—silt loams and clay loams, etc., are represented by numerous types having some properties in common but possessing others of marked distinction.

The survey has brought out clearly that not all soils are in need of lime. Some are deficient in the surface layers and yet carry large amounts in the substrata, others are deficient to greater depths, and still others have ample quantities in all layers for crop production. Such information, especially when coupled up with the "Soiltex" method for determining the need of soils for lime, makes it possible to place the liming of land on a much more definite basis than could have been done previous to this time. Maps of several counties showing the location of soils of varying lime needs, have been published and distributed by the Michigan Experiment Station. Other maps are in the process of preparation.

The soil surveyor first makes observations in the field, and later on, determinations in the laboratories on the organic matter present in the soils that are found in a given area. Such inventories have been made, and maps showing the location of the soils carrying different amounts of organic matter, have been completed or are in progress for Berrien, Cass, Van Buren, Ottawa, Muskegon, Barry, Kalamazoo, St. Joseph, Calhoun, Hillsdale, Ingham, Livingston, Macomb, Isabella, and Manistee counties.

The soil surveyors and the men engaged in soil fertility investigations co-operate closely in collecting information and making use of it. The former need the information that the latter obtain through co-operative field trials with farmers, through soil fertility fields, and other methods,—in the classification of the land, and the latter are dependent upon the former for making it possible for them to conduct their fertility studies systematically. It has been found, for example, that certain soil types need lime, others do not need it, some need complete fertilizers, and others do not. Naturally such information may be of immediate and great practical significance. It may be cited, for example, that there may be 40,000 farmers whose land is made up, in the main, of soils that need only phosphorus applications in addition to the crop sequence for their successful management. So far as these people are concerned, such knowledge is useful. The soils in the majority of the counties that have been surveyed have been grouped according to their fertilizer requirements. Maps showing these groups together with fertilizer recommendations will be distributed in a short time.

My interpretation of the Michigan State soil survey is that it is a fact-finding organization,—facts primarily for utilitarian purposes. The accomplishments of the survey thus far, as above enumerated, are of tremendous and far-reaching importance; they are second to no other organization in this country during this period. The sandy lands of the lower Peninsula of Michigan have been described and classified, their general locations pointed out and suggestions have been made concerning their agricultural possibilities. In the detailed surveys the soils have been described and classified with respect to production, lime content, vegetable matter content and fertilizer requirements. Finally, the investigations conducted in conjunction with the soil survey have proved that the opinions held by some, to the effect that the soils of Michigan are in the main unweathered, glacial débris, have no foundation.

THE USE OF NITROGEN IN MUCK FERTILIZATION

The Value of Nitrogen in a Fertilizer Mixture Depends upon the Type of Muck and the Crops to be Grown

PAUL M. HARMER, SOILS SECTION.

In a discussion on the use of nitrogen in a fertilizer mixture on muck land, the first consideration is that of the type of muck. The muck soils of the State may be roughly divided into three classes according to their lime content: First, those which contain a good supply of lime; second, those which are low in content of lime and which require an application of marl or ground limestone before satisfactory yields of most crops can be produced; and third, a transitional group, intermediate in lime content between the low-lime and high-lime mucks, which may or

may not require lime, apparently depending both on the lime content of the muck layers to a depth of two or three feet, and also on the crop which is to be grown.

Usually the low-lime mucks can be distinguished from the high-lime mucks by their natural vegetation. The majority of the low-lime mucks support a natural growth of sphagnum moss and heath shrubs, such as the leather leaf, huckleberry (swamp blueberry), Labrador tea and cranberry. In the more northern areas, this vegetation may be more or less displaced by a dwarf tamarack or a dwarf tamarack and black spruce forest. In that section there are also some low-lime slough grass (sedge) marshes. In reaction, the low lime mucks are generally very strongly acid (Soiltex test), the high-lime mucks, alkaline to moderately acid, and the transitional group, moderately to strongly acid.

Low-Lime Muck. In general the nitrogen content of low-lime muck is from one-half to two-thirds that of high-lime muck. Further, the low-lime muck is usually much less decomposed and the nitrogen apparently less available than that of the high-lime. Table 1 presents yields of several crops grown on very acid mucks, which had received an application of ground limestone or marl. In all cases lime was absolutely essential for crop production. With the exception of potatoes, the yield of all crops on the unlimed muck was zero for all plots, whether fertilized or unfertilized. On the unlimed plot, the yield of potatoes did not exceed one bushel per acre in 1922 or three bushels per acre in 1923. When applied before planting, the application of nitrogen with potash and phosphoric acid produced increased yields of millet, potatoes, spring rye, and sweet clover, but no increases of sugar beets or rutabagas. When the fertilizer was applied in installments, one-third before planting and one-third at intervals of one month, a considerably greater response to the inclusion of nitrogen was given by all crops on which the test was made. This is probably due to the fact that the feeding zone for a crop on a low-lime muck is limited to the limed surface layer. As soon as the fertilizer is leached beneath that layer, it is lost to the plant. Since nitrate is readily leached out, its application in installments is, therefore, especially desirable. As the lime works downward and neutralizes the acids of the underlying layers, the response to a nitrogen-carrying fertilizer may decrease. It is probable, however, that for several years after liming a low-lime muck, the inclusion of nitrogen in the fertilizer mixture will prove beneficial for most crops.

Table 1.—Effect of nitrogen on yield of several crops on very acid mucks which had been limed or marled

Fertiliser application (1)	Hungarian millet lbs. per acre		Potatoes bu. per acre		Sugar beets lbs. per acre	Rutabagas tons per acre	Celery lbs. per acre	
	1922	1923	1922	1923	1922	1924	1923	1924
No fertiliser	67	170	11.3	13.3	67	1.1	3,429	5,306
P K (Application before planting)	3,155	1,276	43.5	62.7	2,135	4.0	....	....
N P K (Application before planting)	4,305	2,297	44.0	75.7	1,115	3.1	....	....
P K (3 installments) (2)	....	1,489	....	57.9	....	5.3	9,099	12,904
N P K (3 installments)	....	3,233	....	91.2	....	5.8	9,900	18,162

High-Lime Muck. The effect of a nitrogenous fertilizer when used alone, and with potash and phosphoric acid on several crops is shown in Table 2 for several different high-lime muck soils. It is apparent that little or no increase is produced by nitrogen when used alone. From experimental work, carried on by this and other Stations, it is evident that, on any crop grown on muck land, the use of nitrogen without the preceding or accompanying addition of potash or of potash and phosphoric acid fertilizers, when the latter is needed, is a decided waste of fertilizer.

The amount of benefit resulting from the application of nitrogen along with potash and phosphoric acid on high-lime muck land, is probably dependent on several factors, among which are: the kind of crop, season of planting, seasonal climate, extent of drainage, depth of muck, and past fertilization. Muck which has been well manured in the past, is not likely to be benefited by the inclusion of nitrogen in the fertilizer mixture, except for certain special crops. Shallow muck, cropped for a number of years without the addition of heavy applications of manure, will frequently respond to the addition of nitrogen in the fertilizer mixture. Poor drainage or cold wet seasons tend to decrease the rate of decomposition of muck soil and, consequently, the availability of the soils nitrogen. This was quite apparent in 1924, during the cool, wet, early summer of which, a greater response to nitrogen was secured from several special muck crops than is ordinarily obtained.

Table 2.—Effect of nitrogen, when applied alone and in combination with potash, on yields of several general farm crops grown on high-lime muck.

Type of Muck	Shallow Muck	Sedge Marsh moderately acid		Ash and tamarack swamp		Tamarack swamp	
Fertilizer application	Sunflowers tons per acre	Corn bu. per acre	Stock carrots tons per acre	Sugar beets tons per acre	Corn bu. per per acre	Rape green tons per acre	Sugar beets tons per acre
No fertilizer	21.1	13.8	6.1	2.3	9.7	18.6	7.5
N	22.4	9.4	5.5	2.5	5.9	18.3	8.9
K	25.4	60.2	22.5	8.2	70.7	23.3	10.6
N K	28.3	51.2	25.4	11.1	68.6	23.3	10.9

In the case of some of the special crops, of which several successive plantings are made, a greater benefit results from the addition of nitrogen for the early than for the mid-season plantings. In the case of late celery, the application of a nitrogen fertilizer about the time of banking will often produce a considerable increase in yield.

Of the several factors which determine the results from the application of a nitrogen-carrying fertilizer on muck, the most important is the

(1) In this and the following tables
N—Nitrate of soda or sulphate of ammonia
P—Acid phosphate
K—Muriate of potash

(2) In the case of celery, one-fourth of the nitrogen was applied at planting and three-fourths at banking.

kind of crop being grown. In Table 3 is given the results obtained from trials with a number of crops, fertilized with and without nitrogen included in the mixture. In the case of the general crops, there is little or no increase in yield resulting from the addition of nitrogen. Considering the special crops,—the root crops, parsnips and table carrots show little benefit, while table beets show a slight increase. The remaining crops,—onions, celery, cabbage, cauliflower and Swiss chard give marked increases in yield of the plots receiving nitrogen over those receiving only phosphoric acid and potash. To this list should be added spinach and lettuce.

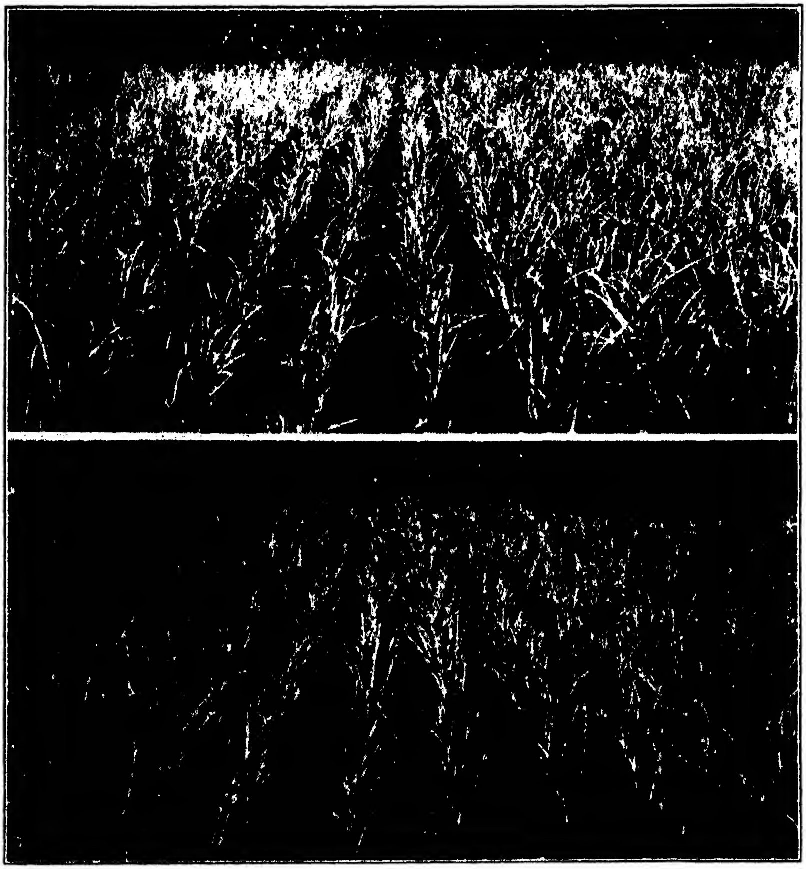


Fig. 1.—The onions in both pictures received phosphoric acid and potash while those in the lower picture also received nitrogen. The growth of tops was considerably increased by the addition of nitrogen, while the yield of marketable onions was increased 70 bushels per acre. Photographed July 8, 1924.

Table 3.—Effect of nitrogen, when applied in combination with phosphoric acid and potash on several different crops, on high-lime muck

General Crops

Natural vegetation	Shallow muck		Mixed forest swamp		Sedge marsh		Mixed forest	
Fertilizer application	Alfalfa tons per acre	Potatoes bu. per acre	Timothy tons per acre	Oats bu. per acre	Turnips tons per acre	Sugar beets tons per acre	Sweet clover tons per acre	Sugar beets tons per acre
P K........	3.1	228	2.3	63.2	15.9	6.8	2.4	10.7
P N K......	3.4	195	2.4	57.4	15.4	7.6	2.8	10.4

Special Crops

Natural vegetation	Black Elm and tamarack swamp		Tamarack swamp	Sedge marsh				
Fertilizer application	Onions bu. per acre (2 yr. av.)	Celery (in rough) tons per acre (2 yr. av.)	Cabbage marketable heads tons per acre	Cauliflower tons per acre (2 yr. av.)	Swiss chard tons per acre	Parsnips tons per acre (3 yr. av.)	Table beets tons per acre (3 yr. av.)	Table carrots tons per acre (3 yr. av.)
P K........	495	15.1	20.6	4503	21.6	8.5	17.1	18.8
N P K...	574	20.8	22.5	6144	25.3	8.7	19.4	18.8

Other trials indicate that, with the exception of onions, manure may be used with the phosphoric acid and potash and the nitrogen requirement of these crops thus taken care of without the purchase of commercial nitrogen. If the crop is to be an early planting, however, the use of a readily available nitrogenous fertilizer will generally give better results than will manure. This is especially true with onions, since readily available commercial nitrogen tends to give the crop a quicker start than does manure, the application of the latter also produces a much larger proportion of scullions. If commercial nitrogen is used on lettuce, it must be applied in several installments to prove as effective as manure.

THE SAMPLING OF SOILS

The Various Layers of the Soil Profile must be Considered in Determining the Value of the Soil

J. O. VEATCH, SOILS SECTION

It is now recognized among soil scientists that the old, simple division of the soil into *soil* and *subsoil* is no longer adequate, either in con-

nection with problems of soil management or for the purpose of the Soil Survey which deals with soil classification and soil mapping.

According to the newest conception, the soil in a proper sense includes the whole thickness of weathering or the whole depth to which the rock formation (whether hard rock or unconsolidated deposits like the Glacial formations of Michigan) has been changed by soil forming processes. The soil then is further divided into its natural parts, or separate layers, which are known as *horizons*. The soil horizons considered collectively constitute the *soil profile*. There are three principal divisions in the profiles which include most of the soils of Michigan. These are designated by the letters, A. B. and C. These may be further subdivided, so that a soil may consist of as many as five or six distinct parts. A profile of one of the more important types of soil in Michigan is here given for illustration.

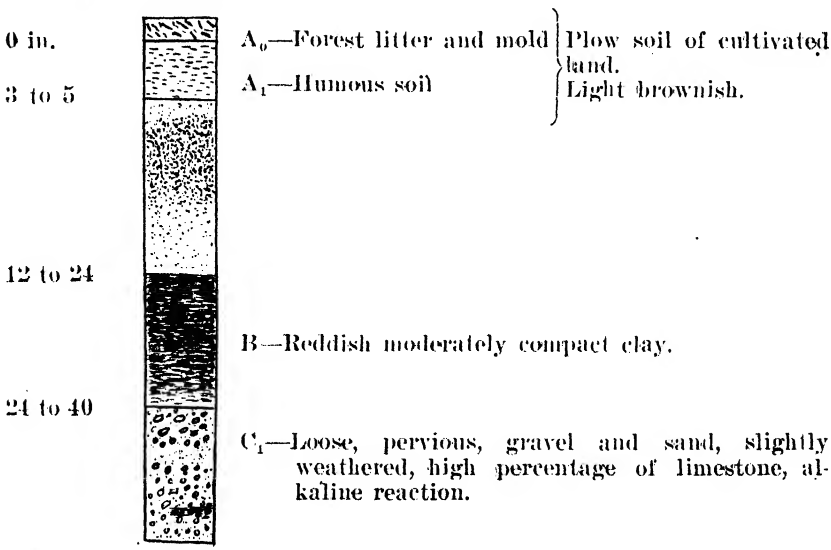


Fig. 7.—Profile of a soil showing the various horizons.

Observation has shown that the roots of a great number of the common herbaceous cultivated plants, as well as of the trees and shrubs are by no means entirely confined to the surface or plow soil, but penetrate the various soil horizons. It is, therefore, reasonable to assume that the underlying soil horizons play an important part in plant growth. For example, in the soil type, illustrated by accompanying profile, the roots of alfalfa and red clover commonly penetrate through the sandy surface horizons, which are acid, into the reddish, clayey horizon B, and thence into the limey substratum below.

In the sampling of soils, it follows from the foregoing statements that the most logical procedure would be to collect samples by *horizons* whether the purpose be for purely scientific study and soil classification, or whether the samples be collected by the land owner or farmer for the purpose of getting information about management, liming,

fertilizing and crop adaptation. A sample of the surface horizon or the plow soil, alone is generally insufficient. Collecting samples at arbitrary depths, for example to 6 inches, thence 6 to 12 inches, etc. is an improvement but is not entirely satisfactory for all purposes since horizons or layers quite different in nature are thereby mixed. Since it would rarely happen that the same mixtures would be collected by different persons, such samples would have only small value for purposes of comparison and for determining the type in the scheme of soil classification.

For most of the soils in Michigan, it is important to collect separate samples of at least three of the different layers or horizons: (1) the plow soil or the surface horizon of virgin soil; (2) the soil just beneath No. 1, which is likely to be leached, lighter in color, sandier or less coherent and less loamy in structure; (3) the more clayey or more compact soil, the horizon B. There is a great variation in the depth to horizon B when all of the soils are considered, since this may be found to range from 8 or 10 inches to 2 or 3 feet. In some of the well drained sandy types of soils, the more clayey or B horizon is not easily distinguished. The general rule to follow in the complete sampling is to note any changes in such things as color, and clay content, structure, as "hardpans", etc., and then collect samples according to the different layers observed in the boring or excavation.

Certain classes of soil, such, for example, as recently deposited stream bottom soils, some of the dune sand and mucks, do not exhibit a profile in a technical sense. The general rules in the sampling of such soils will apply, however.

COMMERCIAL FERTILIZERS FOR GRAPES

The Use of Nitrogen is Likely to be Very Profitable in Vineyards Where the Soil is Light and will not Support Vigorous Vine Growth

N. L. PARTRIDGE, HORTICULTURAL SECTION.

Two sets of experiments have been conducted by the Michigan Agricultural Experiment Station on the use of commercial fertilizers in Concord grape vineyards. The vineyards used in these tests are located in Van Buren county on soils of very different types. The first is a medium type loam that is naturally fertile. This vineyard was comparatively vigorous at the time these tests were started. The second vineyard was on a sandier, less fertile soil and the vines were making a rather weak growth at the time that the tests were started.

The fertilizers were applied at the time the buds were breaking in the spring. They were broadcasted so that there was a fairly uniform covering over all the ground. In practice, about the same results are obtained where the fertilizer is distributed by means of a drill in be-

tween the rows. In the tests reported on in the following tables the nitrogen was applied in the form of nitrate of soda and at the rate of 200 pounds to the acre. However, other tests were made in the weak vineyard as to the relative effectiveness of applications of 150 pounds of ammonium sulphate and 200 pounds of nitrate of soda. No important difference was observed in the results that were obtained.

Table 1.—The results obtained in the fertile loam vineyard are as follows:

	Treatment and average yield of fruit per vine, pounds.				
Year	Unfertilized	Nitrogen	Nitrogen phosphorous	Nitrogen potash	Nitrogen, phosphorous, potash
1921	7.4	8.4	8.1	7.7	8.0
1922	19.4	24.1	22.6	22.0	22.6
1923	22.9	21.6	22.8	22.9	22.3
1924	18.7	18.8	20.0	22.6	22.4
4 year total yield	68.4	72.9	73.5	75.2	75.3
Increase for the 4 years		4.5	5.1	6.8	6.9
	Average weight of prunings per vine, pounds				
1921-22	1.8	2.1	2.2	2.0	2.2
1923-24	2.1	2.5	2.6	2.8	2.9
Increase in weight of prunings over first 2 year period	0.3	0.4	0.4	0.8	0.7

The increase in yield of the fertilized over the unfertilized plots during the four years of the test is not very marked. Even in the case of the two treatments showing the largest increase this amounted to only 10 per cent. However, the unfertilized plot yielded comparatively heavy. Excluding the crop of 1921 which was only about one-third of the normal size because of a serious spring freeze, its annual average yield per vine has been 20.3 pounds. This is the equivalent of 8,830 pounds or nearly four and one-half tons to the acre. It is not desirable at this point to consider all the factors which may be responsible for the small difference in yield between the fertilized and unfertilized plots. The important fact is that fertilization has not been very profitable in this naturally fertile vineyard. The rather small increases in yield that were obtained seem to have been due mainly to the use of the nitrogenous fertilizer, rather than to the phosphate or potash. The results also indicate that the use of nitrogen is likely to be very profitable in vineyards where the soil is light and will not support vigorous vine growth. Where the vines are stronger, the return to be anticipated is not so large, though it may be sufficient to yield a profit.

Attention should be called to the fact that the principal influence of commercial fertilizers is on the chemical rather than the physical condition of the soil. In order to keep the soil in good physical condition, it is necessary to maintain the supply of organic matter. Where

manure is not available, cover crops should be grown every year in addition to the application of nitrogen-carrying fertilizer.

Table 2.—Results obtained in the sandy rather infertile vineyard are as follows:

Treatment and average yield of fruit per vine, pounds.

Treatment	Unfertilized	Nitrogen	Nitrogen, phosphorous	Nitrogen, potash	Nitrogen, phosphorous, potash
1923	5.4	4.8	4.5	4.7	4.6
1924	13.6	20.0	19.9	20.0	19.9
2 year total yield	19.0	24.8	24.4	24.7	24.5
Total increase for the 2 years	....	5.8	5.4	5.7	5.5
Average weight of prunings per vine, pounds					
1922-23	1.0	0.9	0.8	0.8	0.8
1923-24	1.0	1.6	1.5	1.5	1.5
Increase in weight of prunings	0	0.7	0.7	0.7	0.7

The crop the first year of the test was very small because of the very poor condition of the vines. It was necessary to prune the vines severely to give them an opportunity to recover some of their vigor. As the plot whose vines were the most vigorous at the commencement of the test was used for the check, it yielded the highest in 1923. However, the vines receiving nitrogen became more vigorous while the check vines remained pretty much as they were. In 1924, the vines receiving nitrogen yielded 46 per cent more grapes than those on the unfertilized plot. This increase was partly due to larger size of bunches and was accompanied by better maturity of fruit than was found on the check vines. The amount of the increase shown by the 1924 crop was 6.35 pounds per vine, or over 1.3 tons per acre. After subtracting the cost of the fertilizer this would leave a nice profit.

The results so far obtained indicate that nitrogen is the element which is most likely to give satisfactory returns when applied to Michigan vineyards, though of course, it is possible that other elements may prove to be beneficial under certain conditions.

OAT VARIETY TESTS IN ST. CLAIR COUNTY

The Wolverine and Worthy Oats were the high yielding varieties on the heavy soils of this section of the State.

D. F. RAINEY, FARM CROPS SECTION.

In 1924, two oat-variety experiments were conducted in St. Clair County. These tests were to compare the yielding ability of the Wolverine and Worthy oats with that of varieties being grown locally.

The Wolverine and Worthy oats are varieties developed by the Michigan Agricultural Experiment Station. They were selected over the other varieties in the trial tests at the Station because of their higher yielding ability. The Danish, Big 4, and Mammoth Cluster are the more or less common varieties being grown in the eastern section of the state.

With the varying soil and climatic conditions in Michigan, there may be localities in which another variety will outyield the Wolverine or Worthy. The result of these two experiments however, would indicate that such is not the case in the Thumb and Saginaw Valley districts.

Those listed as Wolverine U. P., were Wolverine oats secured from the Upper Peninsula Agricultural Sub-Station at Chatham.

Table 1.—Yields secured in two oat-variety tests in St. Clair county.

	Ralph Babcock Jeddo	North Westbrook Marine City	Average
Wolverine, U. P.	75.72 bu.	74.31 bu.	75.01 bu.
Wolverine	73.38 bu.	73.03 bu.	73.20 bu.
Worthy	65.47 bu.	76.73 bu.	71.10 bu.
Big Four	73.00 bu.	67.25 bu.	70.12 bu.
Danish	57.82 bu.	71.50 bu.	64.66 bu.
Mammoth Cluster	64.08 bu.	56.11 bu.	60.09 bu.

The above results were secured on the heavy soils of St. Clair County which are quite typical of the Thumb and Saginaw Valley sections of the State.

FIBER FLAX PRODUCTION IN MICHIGAN

The General Cultural Methods to be Considered in the Production of this Crop

C. R. MEGEE, FARM CROPS SECTION.

The fertile clay loam and loamy soils of the Thumb and Saginaw Valley are exceptionally well suited to the production of fiber flax. The demand for the fiber, however, varies greatly from year to year, and whether or not the crop is a profitable one for the farmer to grow will depend almost entirely upon the connection which he is able to make with parties in position to dispose of the fiber. It is usually advisable to make this connection before the crop is sown.

Probably no other field crop responds to a greater extent to environmental conditions under the control of the farmer than fiber flax. The thickness of planting, whether sown in seven-inch rows or sown broadcast, whether the soil is naturally fertile or whether large quantities of fertilizer must be applied, will determine very largely the success with this crop. Equally as important is the type of soil and the firmness of the seed, as well as the kind of seed sown.

Fig. 7.—A Field of Fiber Flax in the Shock. Thumb Section of Michigan.

One of the first steps in growing a successful crop of flax is to select a piece of ground that is naturally fertile,—a clover—timothy sod, that has been fall plowed, is excellent. A clover or grass sod cropped one year to sugar beets is also desirable.

According to some of the most successful growers, the ground should be in a condition so that large quantities of commercial fertilizer will not have to be applied. Heavy applications of nitrogen tend to give a succulent vegetative growth, which decreases the percentage of fiber.

Fiber flax is best adapted to the clay loam soils of the Thumb and Saginaw Valley sections. It may be grown successfully on the heavy soils of other sections of the state, but it is not adapted to the sandy soils that become droughty during the summer and stunt plant growth. Neither is fiber flax a good crop for muck lands, due to the excess nitrogen which they contain, causing a succulent growth and a low percentage of fiber.

Fig. 8.—Fiber Flax Being Transported from the Field to a Large Storage Shed.

For fiber flax production a fairly heavy subsoil is preferable, since it tends to hold the moisture and the plants do not suffer from dry spells but have a continuous growing season, which is very desirable for flax. Since best results are secured on uniform fields, drainage should not be overlooked.

Care should be used in securing pure fiber flax seed if a fiber crop is desired. The type of flax grown in the northwest for seed production is not at all adapted for fiber production. A fiber flax plant is tall with very few branches, while a typical seed flax plant is short and very heavily branched.

A carefully prepared seed bed is essential to profitable production. The ground should be carefully ploughed and well worked down, so that the seed will be uniformly covered and the stand will make a uniform growth from the start.

Flax is usually sown broadcast to prevent an excessive amount of branching. When drilled in seven-inch rows, as wheat and oats are usually sown, a large amount of branching takes place on the side of the plant next to the open space in the row. This is undesirable since plants with many branches do not yield as high a quality of fiber as plants with only a few branches.

Any machine that will evenly distribute the seed over the ground is suitable for sowing. If the seed bed has been quite firmly compacted, the seed may then be covered with a spike-tooth harrow. If the seed

bed is quite loose, the harrow will arrange the seed in rows somewhat the same as when the seed is sown with an ordinary grain drill. The average rate of sowing varies from seventy-five to ninety pounds of seed per acre. The land should be quite free of weeds, since the separation of the weeds from the flax is practically impossible.

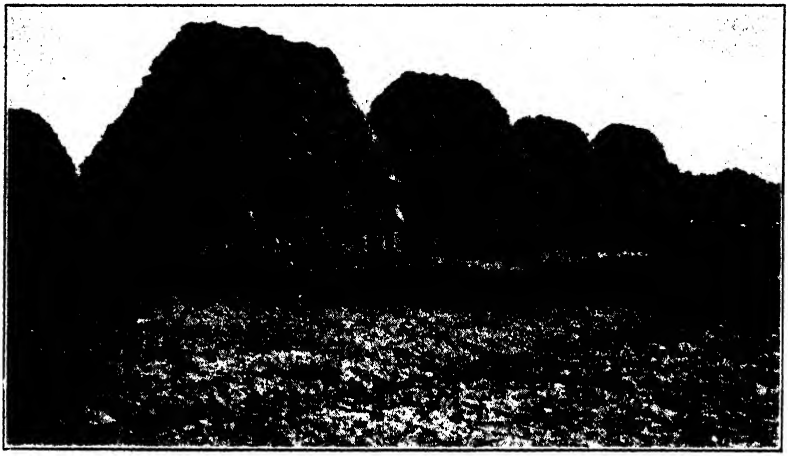


Fig. 9.—Fiber Flax May Be Put in Stacks or Ricks, Much the Same as Wheat or Oats.

The method of harvest will depend very largely upon the use that is to be made of the fiber. Hand-pulling has been practiced pretty largely in the past. However, some method of harvesting with machinery will very likely be developed in the near future.

Retting is essential in order that the fiber may be successively separated out. There are three methods of retting—dew, water and chemical. In dew retting the flax is placed in long rows on a grass sod until the fiber can be separated. The length of time required will depend upon the amount of dew, rainfall and the temperature. Dew retting is the method most frequently used under Michigan conditions.

Water retting consists in the bundles being placed in a vertical position and weighted down in large concrete tanks of water. When the retting process is completed, the fiber is dried by being passed through a large drum, through which hot air is fanned.

Chemical retting consists of the use of chemicals to hasten the rotting of the woody portion. The fiber from chemical retting is very often harsh and brittle and of poor quality.

Breaking consists of passing the retted flax through a series of corrugated rollers. The object is to break the woody portion of the straw into fine pieces so that it can be removed is scutching.

The object of scutching is to remove the woody portion of the stem from the fiber and consists of gradually exposing the broken straw to a revolving, fan-shaped iron wheel. The broken straw is turned and shifted until nearly all of the woody pieces or shives are removed.

FARM ICE CREAM MAKING

Every Farmer should put up Ice, and by Following the Suggestions in this Article easily make his own Ice Cream

P. S. LUCAS, DAIRY SECTION.

There is a luxury commonly neglected on the farm which city folks are taking advantage of—that of home-made ice cream. In many cases ice creams are not made on the farm because of lack of ice. Few sections however, offer the facilities for storing ice that Michigan offers. Our state is dotted thickly with lakes and streams, and seldom is there a winter without an abundance of ice. Ice cream and sherbets are easily prepared and frozen, and require no ingredients not found in the ordinary farm home, except ice.

Ice cream is essentially, frozen, flavored, sweetened, whipped cream. The whipping of air into the mixture gives it a mellow smooth body and a richer taste. The small sized freezer containing a dasher performs this function. Placing a bucket in an ice and salt mixture and rotating this container yields a hard, solid, and, at the best, a soggy ice cream. This is because no air is whipped into the mix to lighten it. The resulting product is much as bread or cake would be without air pockets, though in good ice cream the air cells are infinitely small.

For home manufacture a 20 per cent cream is excellent to use. If a 40 per cent cream is ordinarily skimmed it may be thinned by adding an equal volume of sweet skimmilk. Sugar may be added as per the formulae given later or it may be added to suit the taste. Sugar is added to the cream and stirred in until dissolved. Gelatin is used in commercial ice creams to keep them from becoming icy, but white of egg serves much the same purpose. If gelatin is used, soak each ounce for fifteen minutes in a half tea-cup of cold water, then add a tea-cup of boiling water and stir until dissolved. When cooled it may be thoroughly stirred into the cream and sugar mixture. Vanilla extract is usually added to all flavors of ice cream. The cream mixture may be colored a shade appropriate to its flavor.

A vanilla flavored cream is usually called a "base mix" because any other flavor may be made from it. Chocolate ice cream is made by adding a chocolate syrup to the base mix before it is frozen. This is made by heating cocoa with an equal amount of sugar and water. It is best added to the cream in amounts to suit the taste. To make a fruit flavored cream it is advisable in most cases to add a fruit extract as well as the actual crushed fruit. The base mix is frozen until it is thick like mush, and the fruit is then added. This prevents it from settling to the bottom of the freezer. Canned fruits, jams, or fruit juices may be used.

There is considerable misinformation as to the best methods of freezing ice creams. Ice and salt should be mixed in the approximate ratio of ten to one. The ice may be crushed finely by being beaten in a

gunny sack with the flat side of an axe. Place the freezing can with the mix in proper position in the tub. Fill the ice space half full of ice and sprinkle over it a portion of the salt. Finish filling with ice and pour over the top of it the remainder of the salt. Pour over this enough cold water to half fill the tub. Allow to stand for three to five minutes and then begin turning the freezer. The addition of water will greatly hasten the freezing process. It is a mistake to draw off the brine during the freezing since it is the chilled brine and not the ice which cools and freezes the mixture. When the cream becomes thick and semi-solid the handle will turn only with difficulty. The dasher may then be scraped off, removed, the can lid replaced, and the ice cream left to stand in the brine and ice until solid.

The following formulae are sufficient for one gallon frozen cream:

Vanilla

4 pounds 20 per cent cream
7/8 pound sugar
2 tablespoons gelatin
1 teaspoon vanilla extract
For fruit or nut creams, add as directed. Bisque may be made by adding broken cakes, macaroons, grapenuts, etc.

Vanilla

3 pounds 20 per cent cream
1 pound condensed milk
7/8 pound sugar
2 tablespoons gelatin
1 teaspoon vanilla extract
For tutti fruitti, add a combination of fruits with shredded cocoanut.

Sherbet

4½ pounds water
2 pounds sugar
½ pound lemon juice
If other flavors are desired, use 1/5 pound lemon juice and 4/5 pound of juice of the flavor desired. For sherbets, pineapple and grape flavors are in demand.

A COLORING MATTER FOR GLYMOL

A Subject of Interest and Value to Cream Buyers

P. S. LUCAS, DAIRY SECTION.

Cream tests are so apt to be misread unless some substance is added to break the upper meniscus, that several states, including Michigan, have ruled that such tests must be read with glymol. This material, probably better known as white mineral oil, has stood the test of time as being the most satisfactory material yet suggested for this purpose. Glymol itself is practically colorless and may be, in those cases where insufficient acid is used in the test, very much the same in appearance as the butterfat column. To obviate this difficulty, its originators, Hunziker and Spitzer, suggested that it be colored red with alkanet root. This is done by wrapping an ounce of the powdered root in a piece of cheese cloth and allowing it to soak about twenty-four hours in a quart of the oil. This material gives a bright red color but has the disadvantages of leaving a sediment in the oil, requiring considerable time for the color to be abstracted, and of fading upon continuous exposure to sunlight. Alkanet root costs eighty cents per pound. The amount required to color twenty-five gallons would cost five dollars.

Because of these difficulties, many Michigan testers buy a prepared "reader." An oil soluble, aniline dye for coloring glymol, which lacks the disadvantages of alkanet root, has been located by the dairy department. This is cheap, quickly soluble, produces a color like that of alkanet root, and is not easily faded by sunlight. This is Newport Oil Red 3 B. S. now sold under the trade brand of Newport Oil Red No. 13044. It is a powdered aniline dye sold by the Newport Chemical Works, Passaic, New Jersey. One ounce costs fifty cents and will color twenty to twenty-five gallons of glymol. The cost per gallon is therefore 2 to 2½c, whereas with alkanet root, it is approximately 20c. Another dye that gave satisfactory results is National Oil Red O. manufactured by the National Aniline and Chemical Company, 357 West Erie Street, Chicago, Illinois. No doubt there are other dyes which would be satisfactory.

The color is best put in solution by making a paste of the required quantity in oil, heat to hasten solution, add the remainder of the oil, and strain the entire quantity through cheese cloth. This should not require over ten to fifteen minutes. There is therefore a considerable saving in time and it will be found there is not the objectionable sediment left as with alkanet root. This colored oil should be used the same as usual i. e., immediately before the test is to be read to avoid the tendency of its mixing with the butterfat. This tendency is greatly reduced through the use of a good grade of white glymol, rather than the cheaper unsatisfactory yellow glymol.

TREATMENT FOR RED-SPIDER

Effective Control of this Pest was secured by Applying Three Sprays in as many Consecutive Days

EUGENIA I. MCDANIEL, ENTOMOLOGICAL SECTION.

In common with others, the writer has experienced great difficulty in really controlling red-spider when infesting plants grown under glass. A comparative test of various sprays and dusts seemed to indicate that the proprietary spraying material called "Lemon oil" gave as good results as any, and that it was perhaps a little better than any of the other sprays tested,—at any rate we succeeded in finding nothing more effective in our tests.

However, no spray proved entirely satisfactory for although immediately after an application, few or no active mites were to be found, still next day, and the day following that, altogether too many mites were present to be accounted for by reinfestation. After a number of these experiences the writer turned to the work of Stuart C. Vinal* when it became apparent that the cause of our failure to control was probably due to the quiescent or torpid periods which occur during the development of the creature. During these periods of short duration (about a day) the pests are very resistant to such sprays as are safe to plants, but on the other hand during the period of activity, they may be killed with comparative ease.

Following out this line of reasoning, sprays were applied to a variety of red-spider infested plants, in groups of three. That is to say for each of three days in succession the plants were sprayed with standard stength of Lemon Oil. The results were most gratifying. Plants so treated appearing noticeably more vigorous and of better color, while close examination failed to reveal more than a very few mites. It is reasonable to suppose that other sprays may prove effective,—perhaps just as effective in three or possibly four applications are applied on as many consecutive days.

*Bulletin 179, Massachusetts Agricultural Experiment Station, November 1917.

THE MINT FLEA-BEETLE

Longitarsus menthae new species MS

L. G. GENTNER, ENTOMOLOGICAL SECTION.

During the summer of 1924, a small brownish-yellow flea-beetle forced itself upon the attention of the mint growers of southern Michigan. The growers became convinced that the beetle was causing serious injury and that its presence limited the period during which peppermint and spearmint could profitably be kept in the ground. A visit to the fields revealed the fact that the pest was a new one, never having heretofore been studied nor named.

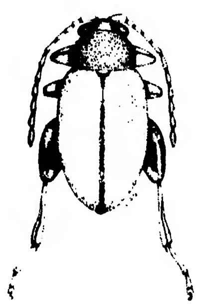


Fig. 10.—Adult male of mint flea-beetle.

The slender, whitish larvae of these beetles feed on the rootlets and mine in the main roots and lower parts of the stems during June, either badly stunting the plants or killing them outright. Injured plants take on a reddish purple tinge which is quite conspicuous at times. The adult beetles first appear during the latter half of July and feed upon the mint leaves, badly riddling them and causing them to turn brown and later to drop off.

Like all flea-beetles, the adults have the hind thighs much enlarged and are able to jump freely, often leaping a foot or more. After feeding for a period of three or four weeks the beetles begin to lay small, yellowish eggs near the surface of the soil, continuing to do so until the beetles die or until severe cold weather sets in. When the mint sod is plowed under after the first good freeze in the autumn, the eggs become covered and receive protection during the winter months.

Mint planted on summer-fallowed or clean-cultivated land is not attacked by the larvae during the first year, but the adult beetles emerging in adjoining, older fields, gradually work their way into the new mint and lay eggs there.

In order to prevent this migration of adult beetles into the new mint it is probable that the dusting of a strip around the edge of the field

with some arsenical dust would be effective. While no tests have been made, a dust consisting of calcium arsenate, one part to twenty parts of finely powdered raw gypsum, would no doubt be effective.

Fig. 11.—Mint leaves riddled by adults of mint flea-beetle, about natural size.

Few eggs are laid before the mint is cut for distilling, therefore it is likely that the dusting of the second growth and remnants in infested fields soon after harvest, will kill the beetles before any eggs are laid. Volunteer mint along ditch banks furnishes a natural breeding place for the beetles and consequently all volunteer mint in the vicinity of mint fields should be destroyed.

A complete illustrated account of this insect, including a description of the various stages, the habits of the beetle, the nature and extent of injury as well as suggested control measures will be offered for publication in bulletin form shortly.

TWENTY YEARS OF LEGUME INOCULATION

A Brief Review of One Service Rendered to the Farmer by the Bacteriologist

R. M. SNYDER, BACTERIOLOGICAL SECTION.

In 1905, Harrison and Barlow of the Ontario Agricultural College placed before the public a successful culture to inoculate legumes, the organisms being grown on the surface of a jelly. Work previous to this time had been unsuccessful, due to lack of sufficient knowledge of the physiology of the organism. The subject of legume inoculation is an extremely complex one, and in spite of twenty years of research and careful field experience, we have yet to learn much regarding the uses, adaptabilities and limitations of legume cultures in the field. The short space available for this article does not permit extended review of the accomplishments in this subject during the past twenty years. Suffice to say that the articles dealing with this subject are numerous and not always luminous. A few of the most outstanding developments may be summarized as follows:

1. There exist different groups of these organisms, and each group will inoculate certain legumes. Much of the work during the past decade has consisted of studies on crop inoculation, to determine which group specific legumes will fall into. Eleven groups have been observed so far and the probabilities are, however, that as work progresses more of these legume groups will come to light. Only six of these groups are of economic importance in Michigan. They are as follows: The alfalfa group which will inoculate alfalfa or sweet clover; the common clover group which will inoculate any of the common clovers such as red, alsike, mammoth, and white; the field pea group which will inoculate field peas and vetch; the field bean group; the cow pea group; and the soy bean group. Bacteria isolated from the nodules of any plant of any one legume will inoculate any other legume within its own particular group; for instance, bacteria from alfalfa will inoculate sweet clover and vice versa.

2. These various strains of legume bacteria differ as to their ability to withstand acid conditions in the soil. The alfalfa group are the most sensitive and the soy bean group the least sensitive of any of these six economic groups. The failure to recognize this fact has been responsible for many of the unfavorable results that have been obtained in the past. It is futile to inoculate seed which is to be seeded in a field too acid to tolerate the particular plant and organism concerned.

3. Much has been learned in recent years regarding the physiology and physiological efficiency of different legume strains of bacteria. Some strains promote vigorous fixation of nitrogen, while others seem to be for the most part, non-symbiotic in their relation. It is desirable therefore, to select strains that are high in their physiological efficiency and furthermore to handle such strains in the field so that their physiological efficiency shall be unimpaired.

The Bacteriological Laboratory at East Lansing, will be able this coming season to furnish farmers in Michigan with legume cultures at cost, as has been its practice in the past. A nominal charge of twenty-five cents per culture is made to cover cost of preparation and shipping. In a majority of cases, cultures are also carried in stock by County Agricultural Agents. Those desiring cultures from East Lansing should address their communications to the Bacteriological Laboratory, East Lansing, Michigan.

CULTIVATION OF FOREST PLANTATIONS

The Growth of Trees is Increased by Preparation of Ground and Cultivation

A. K. CHITTENDEN, FORESTRY SECTION.

The question is often asked, particularly with reference to Christmas tree plantations, how much does cultivation stimulate the rate of growth of forest plantations? Does it stimulate growth sufficiently to pay for the cost of cultivation or will the trees grow practically as fast if left uncared for?

The Forestry Department planted two areas to Norway spruce for Christmas trees a few years ago. Each area covered approximately one-fourth of an acre. The first area was a gentle east slope, the soil was a rather stiff clay quite full of small stones. It had not been cultivated for several years and was covered with a heavy growth of June grass. No preparation was given the soil before planting. The trees were planted about four feet apart each way, without removing the grass except where the sod was turned to make a place for each tree. No subsequent cultivation or care was given and the trees were left to shift for themselves.

The other area was practically flat, the soil gravelly clay. It had been fertilized with horse manure at times in the past few years and was fitted and carefully prepared by plowing and dragging before planting. The trees were set four feet apart each way and were cultivated about four times a year since planting so as to keep out weeds and to keep the soil from baking.

The trees used for planting in both cases were 6-year-old transplants, averaging 1.2 feet high.

In the June grass plantation the grass has as yet been very little affected by the trees. It has not been shaded out and is still dense. The trees have not yet established a complete ground cover.

The rate of growth per year of the trees in each plantation since planting has been as follows:

	Annual average height growth in feet		Per cent increase
	Uncultivated	Cultivated	
1st year	0.32	0 52	62
2nd year	0.39	0 58	49
3rd year	0.46	0 71	54
4th year	0.64	1.07	67
Total, (4 years)	1.81	2.88	59
Number of trees measured	694	568	

Preparation of the ground and cultivation apparently increased the growth of the trees considerably. The growth shows an average increase of 59 per cent for the four years. The average height of the trees in the uncultivated plantation at the present time is 3.0 feet, and in the cultivated plantation it is 4.1 feet.

The loss in transplanting was much less in the cultivated plantation than in the other. In the cultivated plantation there was practically no transplanting loss and in the uncultivated plantation the transplanting loss was rather heavy.

Cultivation of a forest plantation, where there is a heavy grass ground cover, results in considerably increased growth of the trees for a few years. If smaller trees had been used for planting, such as seedling stock, it is probable that there would have been a greater difference in rate of growth as the grass would have shaded the trees to some extent on the uncultivated area and there might have been more competition for root space near the surface of the ground. Transplants about one foot high were used as this is the favorite sized stock for Christmas tree plantations. In addition to an increased growth cultivation also reduces the fire danger by eliminating grass and weeds which might carry fire during dry seasons.

On some soils Norway spruce grows too rapidly to make good Christmas trees. The trees become long and spindly. For Christmas trees a rather slow growth is desirable. The growth can be slowed down for the first few years by neglecting cultivation. It should be remembered, however, that the transplanting loss may be heavier if the soil is not prepared for planting.

For a timber crop cultivation is not usually practiced. In forest planting on a large scale preparation of the ground would be too expensive. As soon as the trees begin to form a complete ground cover weeds and grass will be shaded out and the mulch formed by the fall of the leaves will prevent evaporation of soil moisture.

PASTEURIZATION OF MILK

A Brief Description of the Processes Involved

G. L. A. RUEHLE, BACTERIOLOGICAL SECTION.

So much has been said about the pasteurization of milk that the subject would seem to be well nigh exhausted, yet every now and then someone makes a remark which leads us to suspect that, although everyone is familiar with the name for the process, the process itself is not well understood. What is pasteurization? In the first place it should be understood that pasteurization today and pasteurization in the early days, when it first acquired its dark reputation are not the same thing. In those days pasteurizing meant heating the milk to a fairly high temperature, anywhere, say, from 165° F. to 190° F. for anywhere from 10 to 60 minutes. Today, the term pasteurization when applied to market milk means heating milk to 142-145° F. for 20-30 minutes. A further extension of the definition should include prompt cooling to 50° F. and proper safeguards to prevent reinoculation of the milk with undesirable bacteria.

The effect of pasteurization upon the physical and chemical properties of milk has been the subject of much controversy. This was due to the differences in definition of the term pasteurization. There is no doubt but that heating milk to a high temperature imparts a decidedly cooked taste, which is due to several factors,—driving off of the natural gases of the milk, partial decomposition of the proteins, with the production of new compounds and caramelization of the milk sugar. Highly cooked milk also is thought by many to be less digestible than raw milk, although there is still a difference of opinion among good dietitians on this point. High heat also causes a breaking up of the clusters of fat globules into independent fat globules which rise less readily to the surface than the larger clusters. This results in destroying the cream line. However, milk pasteurized by modern methods does not have any of these objections to a noticeable degree. There is no evidence that pasteurized milk has any less food value than raw milk with the exception that vitamine C is partially destroyed. This, however, is easily replaced in the diet by the use of fresh fruits (the juices of oranges, tomatoes, etc., for babies) and greens, so that there is no excuse for giving up the safety of pasteuried milk on account of its deficiency in vitamine C. For, properly pasteurized milk is safe milk, while all raw milk is potentially dangerous. The purposes of pasteurization may be said to be two: first, the hygienic reason, for which the milk is made safe for human use, and second, the economic reason for which the keeping quality of the milk is enhanced.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, East Lansing, Michigan.

LIST OF AVAILABLE BULLETINS

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251 Insects of 1907.
258 Insects of Field Crops.
262 Suggestions on Planting an Orchard.
264 Second Report of Grade Dairy Herd.
267 Michigan Weeds (only to libraries and teachers).
273 Utilization of Muck Lands.
277 Studies in the Cost of Market Milk Production.
281 Trees, Shrubs and Plants for Farm and Home Planting.
284 Some Information and Suggestions Concerning the Use of Phosphorus.
286 Studies and Cost of Milk Production—No. 2.
289 Corn Growing in Michigan.
290 Soil Fertility.

Special Bulletins—

58 Foul Brood.
65 Hog Cholera and Preventive Treatment.
67 Onion Culture on Muck Lands.
70 Michigan Agriculture, Its Present Status and Wonderful Possibilities.
71 Studies in the Range and Variation of the Percent of Butter Fat in the Milk of Individual Cows.
72 Some Ginseng Troubles.
74 Analysis of Some Materials Sold as Insecticides and Fungicides.
76 Transferring Bees.
79 Michigan's Shifting Sands; Their Control and Better Utilization.
80 Yellow Rocket (a dangerous weed).
81 Tomato Leaf Spot.
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83 Key to Orthoptera of Michigan.
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90 Special Report of the Upper Peninsula Experiment Station.
91 Some General Information on Lime and Its Uses and Functions in Soils.
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95 Muskmelon Culture in Michigan.
98 Vinegar.
99 The Detroit Commission Plan of City Milk Administration.
100 Soy Beans.
101 Oats in Michigan.
103 Forest Planting in Michigan.
104 Soils of Detroit Area.
105 Rosen Rye.
106 Sugar Beet Growing in Michigan.
107 Diseases of Bees in Michigan.
108 The Robust Bean.

109 Dependable Michigan Crop Varieties.
110 Special Report of the Upper Peninsula Experiment Station.
111 Studies in City Milk Distribution.
112 An Experiment in Improving the Milk Supply of a City Milk Plant.
113 Sweet Clover.
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132 Field and Garden Insects.
133 Fertilizers. What they are are and how to use them.
134 Greenhouse Insects.
135 Seasonal Management of Commercial Apiaries.
137 *Marketing Michigan Potatoes.
138 *Rural Highways.
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140 *Spraying Calendar.
141 *Profitable Pruning of the Concord Grape.
142 *Grafting in the Apple Orchard.

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28 The Bean Maggot in 1915.
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34 More Wheat for Michigan.
36 Planting the Rural School Grounds.
37 Raspberry Culture.
43 Increasing the Production of the Bearing Apple Orchard.
44 The European Corn Borer.
47 Poisoning from Bacillus Botulinus.
48 Spraying for Hopperburn.
49 The Hessian Fly.
50 Hairy Vetch.
52 The Grape Berry Moth in 1922.
53 Standard Fertilizers for Michigan.
55 Lime Requirement for St. Joseph County.

*The names of new bulletins published since the November Quarterly Bulletin are starred and printed in heavier type.

56 Lime Requirement for Cass County.
57 Lime Requirement for Calhoun County.
58 Lime Requirement for Berrien County.
59 Lime Requirement for Ottawa County.
60 Lime Requirement for Kalamazoo County.
61 Paying for Milk on a Quality Basis as a Means of Improving the Supply.
62 The Simplex Lime Spreader.
63 White Ants.
64 Simple Water Systems.
65 *Alfalfa and Horses.

Quarterly Bulletins—

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Vol. II, No. 4, May, 1920
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20 Clothing for Children.
21 Care for Clothing.
26 Layettes.
27 Jellies, Jams, etc.
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27 The Kitchen Sink.

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29 The Baby Chick.
30 The Production of Hardigan Alfalfa Seed.
31 Capons
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BAHL, SELMER, M. S. - - - Asst. Chemist
PUTNAM, G. W., M. S., Director Upper Peninsula Experiment Station
WELLS, H. M., B. S., Supt. Graham Horticultural Experiment Station
JOHNSTON, S. B. S., Supt. South Haven Horticultural Experiment Station
LANDON, L. - - - Librarian
SCHEPERS, J. - - - Cashier
CAMPBELL, N. W. - - - Bookkeeper
BOGUE, M. V. - - - Bulletin Clerk

SUB-STATIONS

hatham, Alger County, 780 acres deeded. G. W. Putnam, Director.
uth Haven, Van Buren County, 10 acres rented; 5 acres deeded. S. Johnson, Supt.
aham Station, Kent County, 50 acres donated by R. D. Graham, 50 acres purchased. H. M. Wells, Supt.

MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN
Vol. 7, No. 4, May, 1925

MICHIGAN'S AGRICULTURAL DEPARTMENTS

A Brief Review of the Functions and Services of the Michigan State College of Agriculture and Applied Science as Compared to Those of the Michigan State Department of Agriculture

In so far as State aid and supervision of the agricultural interests are concerned, Michigan has two agencies,—the Michigan State College of Agriculture and Applied Science and the State Department of Agriculture. From correspondence received at the College from many Michigan farmers, it is quite evident that there is a good deal of confusion in regard to the location, purposes, and services of the two organizations, hence this article.

The Michigan State College

The Michigan State College of Agriculture and Applied Science, formerly known as the M. A. C. was estbalished in 1857 and is located in East Lansing, a city about three miles east of Lansing. In this institution there are six main divisions where educational work is given to the students in accordance with their various interests. These divisions include the Agriculture, Engineering, Home Economics, Veterinary Medicine, Applied Science, and Liberal Arts.

The Agricultural Division is still further divided into three sections, including Education, Research, and Extension. The Educational Section deals with the classroom instruction of students in the graduate and in the regular four-year undergraduate courses, and in the various short courses in agriculture at the College. The Experiment Station, through its study and research, aids agricultural progress through the development of better crop and horticultural varieties and general cultural methods, improved soil practices, livestock and crop pest and disease control, better marketing methods, and general home and community improvement. This work is carried on in the laboratories in the College and in hundreds of localities over the State. The Extension Division, through its specialists and County Agricultural Agents, makes more easily available to those on the farm, the better practices and methods developed at the College. This work is conducted entirely away from the College and in all parts and corners of the State. In so far as possible, the services of all three of these sections of the Agriculture Division are available, without charge, to Michigan citizens who have a need for such work. These paragraphs cover in a brief way a description of the organization and of the services of the Michigan State College of Agriculture and Applied Science.

The State Department of Agriculture

The State Department of Agriculture was created in 1921 and is located on the seventh floor of the new State Office Building in Lansing, Michigan.

It was established to co-ordinate and correlate the work of bureaus which had been carrying out their respective duties provided by various Legislative enactments concerned in protecting the food producer and consumer. It was with the view of economy and efficiency that these activities were associated in a Department of Agriculture.

The State Department of Agriculture is a regulatory organization. Its duty is to enforce the laws which the Legislature has from time to time placed on the statute books governing matters pertaining to agriculture.

In order to best serve the public, the work of the State Department of Agriculture is divided into two Divisions, the Administrative and the Division of Chemical Laboratories; and into four Bureaus, Agricultural Industry, Foods and Standards, Animal Industry, and Dairying.

The Administrative Division gives legal advice to all departments, issues licenses, and it contains the departments of court records, inspection reports and of bulletins.

The Bureau of Agricultural Industry has charge of the following activities: Collection of agricultural statistics, in co-operation with the U. S. Department of Agriculture; apiary inspection, drainage, and seed control work, including inspection and analysis; distribution of state aid to county fairs, administration of the Land Certification Law, immigration, land colonization, land settlement, guiding and attracting land settlers; and advertising the resources of the state in regard to its agricultural and recreational possibilities. The Orchard and Nursery work is also included in this bureau. It has to do with the licensing and inspection of all nurseries; the control and inspection of nursery stock shipped in from other states and abroad to Michigan, and control work with plant diseases and insect pests.

The Bureau of Foods and Standards has charge of general food inspection and inspection as to purity, labeling, and sanitary conditions of places where food products are manufactured, handled and sold. The Weights and Measures Department, which is in this bureau, handles the inspection of weighting and measuring devices in all places which serve the public. The Fruit and Vegetable Standards work has to do with the enforcement of legally established grades of Michigan fruits and vegetables. The Market News conducts a daily reporting wire and sends out to the press, bulletins pertaining to the markets of Michigan products.

The Bureau of Animal Industry has charge of the livestock disease control work with tuberculosis, hog cholera, sheep scab, and other animal diseases, in co-operation with the United States Department of Animal Industry. The bureau also has charge of stallion registration, meat inspection in slaughter houses, and general supervision of all veterinary activities; supervision of all the state institutional farms and herds, and general supervision of the licensing of dogs.

The Bureau of Dairying has charge of the inspection of milk supplies and Babcock test bottles, and the licensing of milk plants and shipping

stations, supervision of testing of milk and cream; the licensing of operators of Babcock testers, inspection of creameries, cheese factories and condensories, the control of the composition of butter, cheese, milk and condensed milk and ice cream when sold; the inspection and licensing of ice cream plants; the prevention of false advertising of oleomargarine, and the promotion of the dairy industry in general.

The Division of Chemical Laboratories has charge of the analysis of food in general, and of dairy products, beverages and liquors, drugs, kerosene, and gasoline; the licensing, inspection and analysis of commercial foods and fertilizers; the inspection and analysis of insecticides and fungicides; animal pathological and bacteriological examinations and miscellaneous activities such as animal poisoning and food poisoning investigations and the manufacturing of flavoring extracts.

L. Whitney Watkins is Commissioner of the State Department of Agriculture and all communications relating to the activities of this institution should be addressed to the State Department of Agriculture, Lansing, Michigan.

Both the Michigan State College of Agriculture and Applied Science and the State Department of Agriculture are public institutions, belonging to the people as a whole. They are supported and paid for by the taxpayers' money. Everyone is entitled to the services that can be rendered by them.

FEEDING MINERALS TO DAIRY CATTLE

Minerals Are Needed in the Dairy Ration to Maintain the Health and Efficiency of the Herd

O. E. REED AND C. F. HUFFMAN, DAIRY SECTION

It is common information that dairy cattle need minerals as a part of their daily ration. The kind of minerals to feed and the amount required are questions upon which there is a diversity of opinion. Minerals are needed to develop the skeleton and for the proper functioning of the glands and organs of the animal body. When cattle were first domesticated, the minerals found in the natural feeding stuffs were ample to meet the needs for body maintenance and milk production, since only enough milk was produced to give the calf a start in life. The modern dairy cow, however, is a highly specialized machine for the production of milk, which is rich in mineral salts, especially lime and phosphorus.

Not only has the tremendous increase in milk production caused a greater mineral requirement, but the feeds used today are often grown on soils depleted in the essential mineral elements, resulting in a deficiency in the crops grown on such soils.

The natural ration of the dairy cow consists of roughages, such as hay and grass, which are high in certain essential mineral elements. The high producing dairy cow, however, must have the roughage supplemented with concentrates to furnish protein and energy for heavy milk production. Concentrates, especially the cereal grains, are low in certain necessary minerals. The tendency in dairy cattle management is to increase the proportion of concentrates to roughage in order to increase milk production. This means that although the mineral requirement is increased by greater production of milk, the amount of minerals supplied in the feed is proportionately less, which may account for the lack of health in many of the heavy fed and good producing herds.

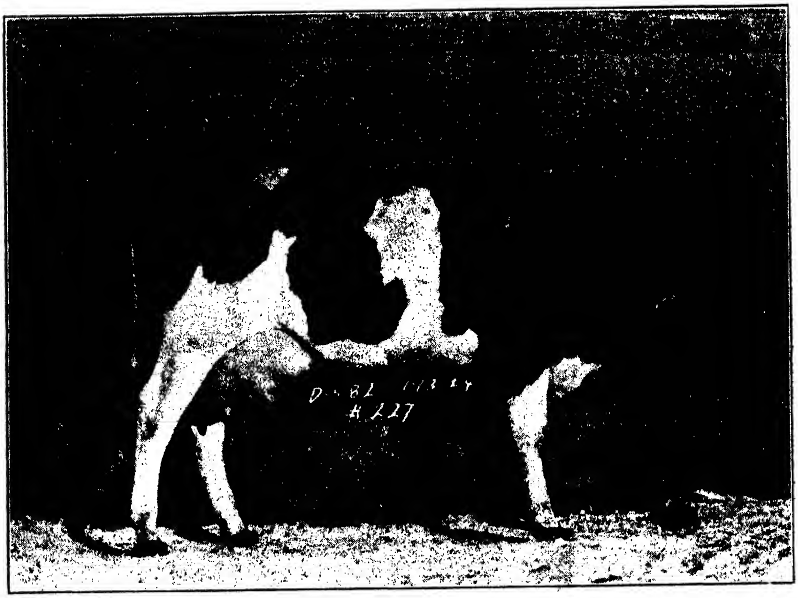

Fig. 1.—This two-year-old heifer was raised on a basal ration of grain, silage, timothy hay, and bone flour as a mineral supplement. Notice the development.

Feeding Salt

The one mineral supplement universally fed is common salt, which is required to a certain extent by all classes of livestock. Salt furnishes sodium, which is needed in the blood, and chlorine, which is used in making hydrochloric acid for the stomach. The salt requirement of carnivorous animals, such as the dog and cat, is very small compared with that of the herbivorous animals, such as the horse and cow. Livestock may be allowed free access to salt or they may be fed at regular intervals, or where grain is fed liberally the salt may be mixed with the grain at the rate of one pound of salt to one hundred pounds of grain mixture.

Iodine in the Ration

A small amount of iodine is needed in the ration of dairy cattle for the proper functioning of the thyroid gland. A deficiency of this element results in goitre or "big neck" in calves. Iodine is often lacking in soils distant from the sea, and consequently goitre is more prevalent in such regions than near the sea coast. Decaying sea weeds liberate this element, which is carried by the wind over the land and taken up from the soil by the crops.

The addition of one-tenth of a pound of either sodium or potassium iodide, finely pulverized, to 100 pounds of salt and this mixture fed to

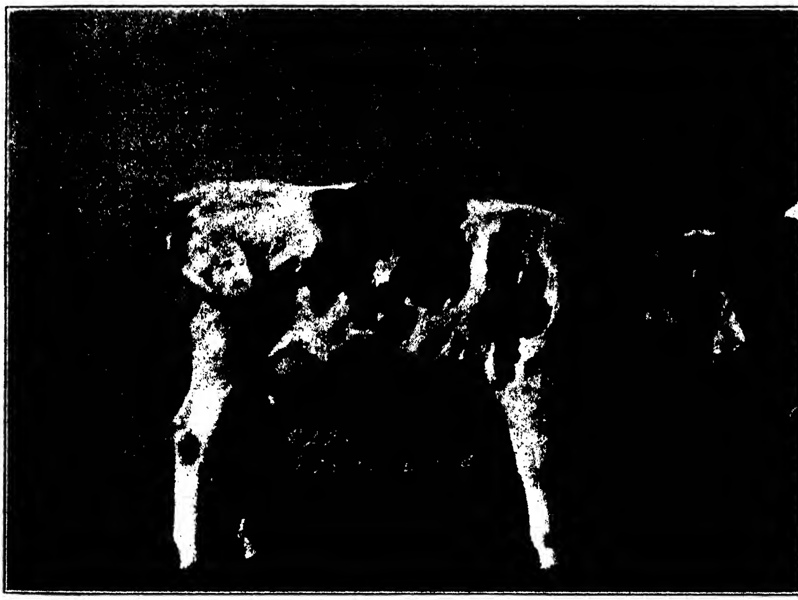

Fig. 2.—This two-year-old heifer was raised on a basal ration of grain, silage, timothy hay, and a complex mineral mix as a mineral supplement. Notice the poor condition and rough coat.

meet the salt requirement, is sufficient, as only a little more than a trace of iodine is needed.

Since milk and butter are very good natural sources of iodine in the human diet, it is important that the cows producing milk for human food receive iodine in their ration.

Lime and Phosphorus

The two mineral elements most likely to be deficient in the lime and phosphorus. These two minerals combined make up per cent of the bone. Lime is also necessary for milk prod

proper functioning of the blood. Phosphorus is not only necessary for bone building and milk production, but also for muscle development. When these two important elements are not supplied in the ration in sufficient amounts and in the right proportion, the result is a loss of lime and phosphorus from the bones which may result in weak bones and diseases of a rachitic nature.

Minerals are also needed for proper reproduction. Considerable lime and phosphorus are found in the skeleton of the foetus. Dr. Hart and his co-workers at the Wisconsin Experiment Station were unable to obtain good reproduction with cattle on the oat plant alone or the wheat plant alone until lime was added to the ration. Dr. Meigs has reported

Fig. 3.—This cow's ration was deficient in lime and the mineral retention vitamin. She gave birth to a premature calf, which was partially paralyzed and only lived 36 hours.

a decrease in breeding troubles on a ration of grain, silage, and timothy hay when calcium carbonate was added to the ration. However, there is no evidence that contagious abortion in cattle can be prevented or cured by mineral feeding.

Legume hays, including alfalfa, clover, soybean, and cow pea hay, are natural feeds high in lime. The following table gives the amount of lime in a ton of some of the common dairy feeds:*

*Feeds & Feeding, Henry & Morrison.

Roughages.	Pounds of Lime Per Ton.
Cow pea hay	50.8
Alfalfa hay	39.0
Soy bean hay	34.4
Red clover hay	32.0
Corn stover	13.0
Wheat straw	5.8
Timothy hay	5.0

Concentrates.	Pounds of Lime Per Ton.
Corn	0.4
Wheat	1.2
Wheat bran	1.8
Oats	2.8
Gluten feed	7.0
Cottonseed meal	7.2
Linseed oil meal	10.2
Beet pulp dried	18.4

The grains, especially the cereals, are very low in lime. As a general rule, roughages are high in lime and concentrates are low in this element. Consequently, the more grain fed in proportion to roughage the more lime needed in the form of a mineral supplement. However, as the table shows, not all roughages are high in this element. Timothy hay and the cereal straws are exceptions and when such roughages are used in the ration, additional lime should be fed in the form of a mineral supplement.

Cows producing less than thirty pounds of milk daily and receiving a legume hay in abundance, do not need additional lime in their ration. However, the high producing cows and those receiving timothy hay should be fed a mineral supplement supplying lime.

Mineral supplements supplying lime in abundance are: Wood ashes, hydrated lime, chalk, finely ground limestone rock, marl, raw rock phosphate, bone meal, bone flour, and bone ash.

Hydrated lime should never be fed to cattle, since it is an alkali and may result in a harmful effect when fed over a long period of time, by neutralizing the necessary acidity of the stomach. Calcium carbonate in the form of marl, chalk, or finely ground limestone rock furnishes lime that can be used in the body, but carbonates also neutralize acids and the effect of continuous feeding of such minerals is not known. However, where considerable silage is being fed, the lime in the form of calcium carbonate may aid in the neutralization of silage acidity. The results at this Station of a long time feeding experiment and a short time balance experiment indicate that raw rock phosphate, especially prepared for livestock feeding, is inferior to special steamed bone meal or bone flour as a mineral supplement. A ton of bone meal contains about 480 pounds of lime.

Phosphorus is found more abundantly in the seeds of plants than in the stems and leaves. Consequently the grains are high in phosphorus, while roughages are low in this element, as the following table shows:

Concentrates.	Lbs. Phosphoric Acid Per Ton.
Wheat bran	59.0
Cottonseed meal	53.4
Linseed oil meal	34.0
Wheat	17.2
Oats	16.2
Corn	13.8
Gluten feed	12.4

Roughages.	Lbs. Phosphoric Acid Per Ton.
Wheat straw	2.6
Timothy hay	6.2
Clover hay	7.8
Corn stover	9.0
Alfalfa hay	10.8

Where a grain mixture containing wheat bran, cottonseed meal, and oil meal is fed liberally, there is little need for additional phosphorus in the form of a mineral supplement. However, where the ration consists of roughages, such as pasture, hay, and silage, and little or no grain, additional phosphorus should be fed. Acid phosphate, raw rock phosphate, and bone meal contain phosphorus in abundance.

Although raw rock phosphate contains as much lime and phosphorus as bone meal, the results at this Station, both in a long time feeding experiment and in short digestion trials, show that special steamed bone meal is superior to raw rock phosphate as a mineral supplement in the ration of growing dairy heifers and milking cows. The high grade raw rock phosphate, especially prepared for livestock feeding, had a detrimental effect on the health of the animals and also prevented them from making good use of their feed. On the other hand, bone meal furnished lime and phosphorus in a form in which it was retained. The results at this Station indicate that when bone meal is fed at the rate of two pounds of bone meal to 100 pounds of grain, that one pound of bone meal actually saves two pounds of total digestible nutrients furnished by other feeding stuffs. Bone meal serves at least three purposes. It furnishes lime and phosphorus and aids in the utilization of other nutrients.

Mineral Mixtures

Many expensive complex mineral mixtures are being fed to dairy cattle. These mixtures usually consist of different combinations of bone meal, calcium carbonate, common salt, copperas, sulphur, Glauber's salts, epsom salts, potassium or sodium iodide, hardwood ashes, and charcoal. The idea of such a mixture being, if one mineral did not do the work another one would. In the past the belief has been prevalent that if a mineral mixture failed to do good, at least it would do no harm. Results at this Station, where heifers are being fed a complex mineral mixture in addition to a basal ration, show that a mineral mixture may be harmful to dairy heifers when fed over a long period at the rate of two ounces of mineral daily. Minerals, such as epsom salts, Glauber's salts, copperas, and sulphur are medicines and should be used accordingly.

Some Simple Mineral Mixtures for Dairy Cattle

Mineral mixture for both growing or milking cattle receiving alfalfa hay and little or no grain.

200 lbs. bone meal or bone flour.
100 lbs. salt.

300 lbs. total mix.

Allow free access to this mixture at all times.

Mineral mixture for heavy producing cows receiving a liberal grain ration, silage and alfalfa hay.

100 lbs. bone meal or bone flour.
100 lbs. calcium carbonate (finely ground limestone rock).
100 lbs. salt.

300 lbs. total mix.

Add three pounds of this mixture to 100 pounds of grain.

Mineral mixture for growing or milking cattle receiving poor quality of roughage (timothy hay, cereal straw, corn stalks, etc.), silage, and a liberal grain ration.

150 lbs. bone meal or bone flour.
150 lbs. calcium carbonate.
100 lbs. salt.

400 lbs. total mix.

Add four pounds of this mixture to 100 pounds of grain.

Mineral mixture for cattle on pasture or receiving roughage low in lime, with little or no grain.

300 lbs. bone meal.
100 lbs. salt.

400 lbs. total mix.

Allow access to this mixture at all times.

On farms where goitre is prevalent, one-tenth pound of finely pulverized potassium or sodium iodide should be added to the above mixtures.

Feeding Minerals on Pasture

The pastures of Michigan are usually low in phosphorus in the spring and early summer, previous to the bloom and seed stages. Where pasture is the only feed at this time of the year, the heavy producing cows often drop in production and in extreme cases depraved appetite follows. Depraved appetite is a craving for things not classed as food, such as wood, dirt, rags, bones, etc. Where pasture is liberally supplemented with grains high in phosphorus, no additional phosphorus in the form of a mineral supplement is needed. Where little or no grain is fed with pasture, bone meal or bone flour should be mixed with salt at the rate of three pounds of bone meal to one pound of salt and the cattle allowed free access to this mixture at all times. Pasture contains the vitamin that aids in mineral retention, which means that the lime and phosphorus of bone meal are efficiently utilized when bone meal is fed to animals on pasture.

The Mineral Retention Factors

The best use of minerals in the ration depends on the presence of a certain vitamin that aids in their utilization. The mineral retention

vitamin is found abundantly in cod liver oil, green feeds, and well cured hay. Cod liver oil is too expensive to use as a cattle feed, except where straw is being fed and no well cured roughage is available. Then about one-half pound of cod liver oil per week will aid in keeping up the health of the animal. Occasionally an animal will become stiff in the joints when a low grade of roughage is being fed. The feeding of cod liver oil and bone meal frequently cures such cases.

Pasture usually furnishes a sufficient amount of the mineral retention factor. However, when pasture is not available, this factor is furnished by well cured hay. Hay should be cured so as to preserve vitamins. This is best done by curing with as little exposure to direct sunlight as possible. Well cured alfalfa hay is the dairyman's best feed, since it supplies lime and vitamins as well as good protein.

Sunlight also aids in the proper use of minerals and cattle should be turned outside in the open air daily in order to get the beneficial effect of the sun's rays and also in order to obtain exercise, which is needed by all livestock, more especially the breeding animals.

Sunlight cannot take the place of nutrients in the feed. Results at this Station indicate that a ration complete in energy and protein is not adequate for proper reproduction even though ample sunlight was obtained daily. The ration of dairy cattle should contain sufficient carbohydrates, fat, protein, minerals, roughage in the form of well cured hay or pasture, and vitamins which are found in most grains, pasture and well cured hay. These should be supplemented with plenty of drinking water, sunlight, and exercise.

IMPROVING THE APPEARANCE OF THE HOME

The Addition of Porches and Sun Parlors, With the Possible Change or Addition of Windows, Will Greatly Improve the Appearance of Many Farm Homes

H. J. GALLAGHER, AGRICULTURAL ENGINEERING SECTION

In a previous issue of the Quarterly Bulletin, interior remodeling of the farm house was discussed, and while correct interior arrangement is of primary importance in either a new or remodeled house, the exterior appearance should be given due consideration. In many cases this consideration has not been given the house and the result is a plain or unattractive dwelling. Such a house fails to give the full measure of enjoyment of a home.

In new construction, the arrangement and grouping of windows, the correct design of porches and sun parlors and good roof lines determine, to a great extent, the attractiveness of the building. These same factors produce as pronounced a result in remodeling the old house. In

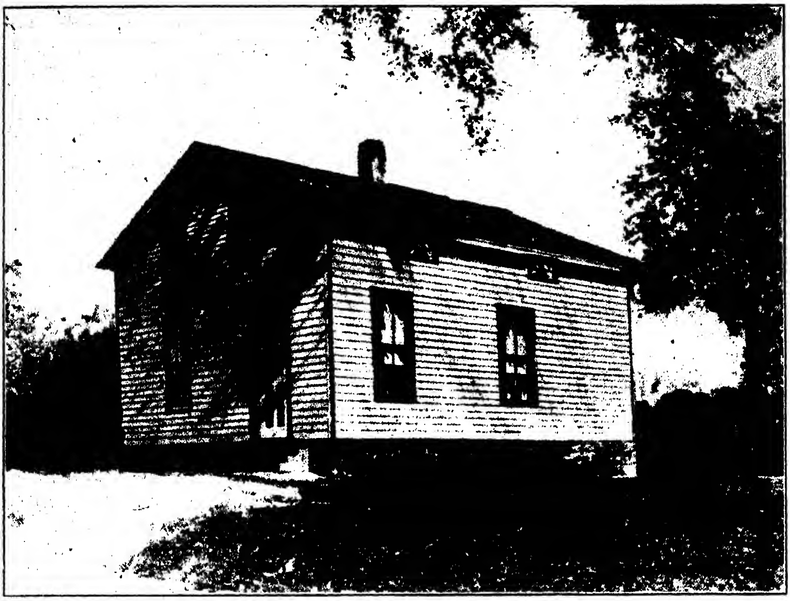

Fig. 4.—A rather plain type of house which lends itself very well to a remodeling scheme such as shown in Fig. 5, which makes it infinitely more attractive and home-like.

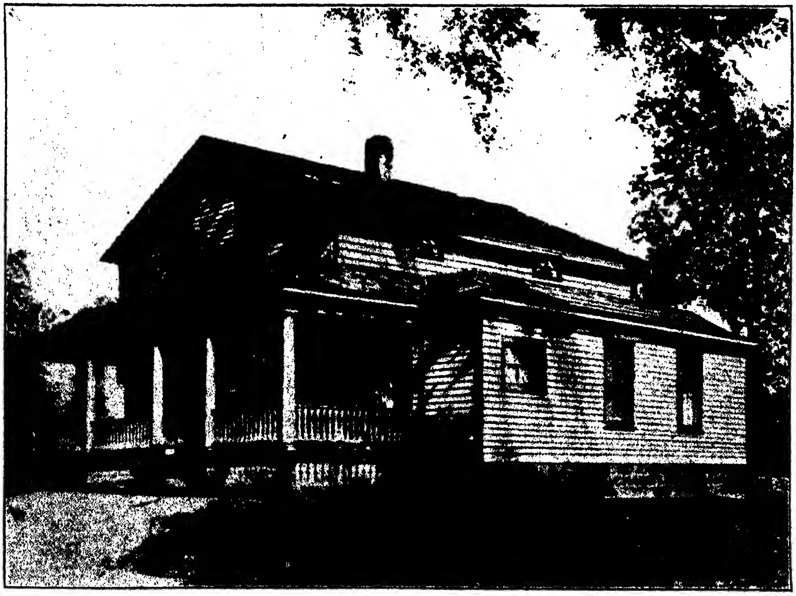

Fig. 5.—The same house shown in Fig. 4 after $600 to $800 had been spent in remodeling.

remodeling, there are more limiting factors to encounter and the problem may be somewhat more difficult; yet most satisfactory results can be achieved that will transform an unattractive building into one that becomes a pride of possession.

The addition of porches and sun parlors with the possible change or addition of windows, will do more to improve the appearance of the old house than almost any other factor.

Fig. 4 shows a house that would hardly draw a favorable comment from the passer-by. It is plain to the point of severity, it lacks the hospitable homelike appearance that is especially desirable for the farm house.

Fig. 5 is the same house, to which has been added a broad commodious porch to the front and a wing to the side. The severely straight lines have been broken up, presenting a pleasing appearance to the eye and giving a homelike air of hospitality and comfort.

Fig. 6 is a house similar in design to Fig. 4, but is much more attractive in appearance due to the small porch in front and the shrubbery, which gives it a more natural setting with the landscape.

Fig. 7 is the same house as Fig. 6. Here the addition of a sun parlor and porch on the side, gives a very well balanced and attractive appearance to the house. Shrubbery plays an important part here, too, in that it more closely harmonizes the house with its surroundings.

From $600 to $800 should cover the remodeling in Fig. 5 and $400 or $500 in Fig. 7.

Fig. 6.—A type of house often found in the country. The trees, lawn and shrubbery surrounding this house makes it much more attractive, and at a small cost, than the house shown in Fig. 4.

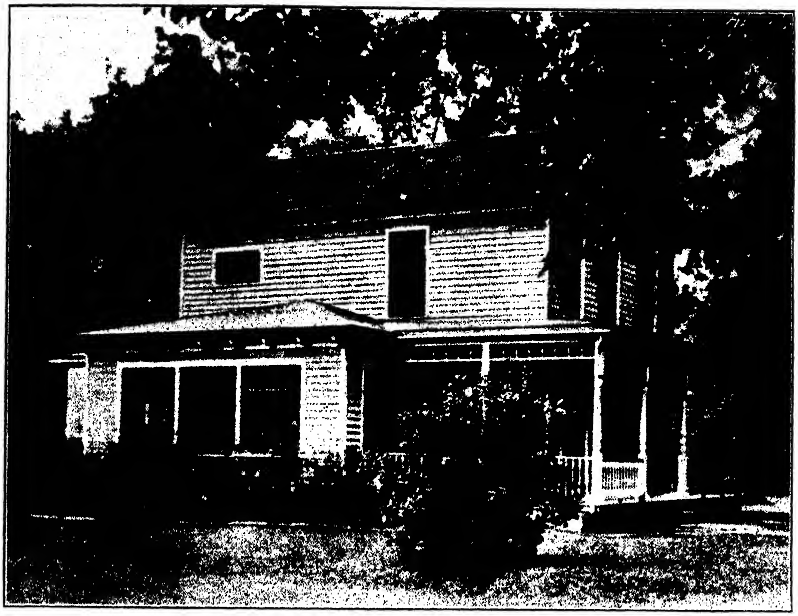

Fig. 7.—The house shown in Fig. 6, after the addition of a sun-parlor and a larger porch which would cost about $400 to $500.

TRACTOR OPERATION COSTS

The Detailed Costs and Related Data of Two-Plow Tractor Power for Nine Farm Operations

E. C. SAUVE, AGRICULTURAL ENGINEERING SECTION

Inasmuch as the gas tractor represents a large money investment, it is desirable to know definitely whether or not that tractor pays.

Frequently one asks, "How much should I charge an acre for plowing in order that I may break even?" Complete tractor costs records have not been available in the past. It is true that valuable information was received from those co-operating with the Agricultural Engineering Department, but in most cases this information covered but a few weeks of the tractor operating season.

We have, however, a full season's record kept by Ralph Partridge of Mt. Morris, on his two-plow tractor. We consider this information especially valuable for those desiring to know the cost of two-plow tractor power. The accompanying table explains in detail, costs and related data of a number of farm operations.

Fig. 8.—Mr. Partridge, spring plowing for oats. The Agricultural Engineering Department of the College is very anxious to obtain co-operators in keeping tractor cost records. Weekly report cards and additional information will be furnished to those desiring to keep such records. Requests for data sheets should be accompanied by the make and horsepower of the tractor; also give the year purchased.

Mr. Partridge's farm consists of 100 acres of clay loam soil and is located 5 miles west and 1/2 mile north of Mt. Morris. Considerable outside work was done as is evidenced by the fact that the tractor worked the equivalent of 53.5 ten-hour days during the year. This compares with the average value of 39 ten-hour days per year for various makes of tractors through the southern section of the state.

Table No. 1.—Two Plow Tractor Cost Record on the Farm of Ralph Partridge, Mt. Morris

Operation	Amount of work per 10 hour day	Gal. of fuel per unit of measure	Gal. of fuel per hour	Qts. of Lub. oil per hour	TRACTOR COST PER UNIT OF MEASURE						Implement Repairs		Tractor Repairs		Per Cent time filling oiling and going to & from field	Year's work in 10 hour days	Per cent of Total Time
					Fuel at 16.3c per gal. av.	Oil at 74c per ga. av.	Wages 50c per hour	Total operating cost	Fixed charges Interest Deprec. Repairs	Total Cost	Hours	Cost	Hours	Cost per Acre			
Plowing Acre unit	*4.16	4.36	1.86	.667	$.71 A.	$.296 A.	$1.20 A.	$2.21 A.	$.79 A.	$3.00 A.	5¾		3¾	$.21	5.6	12.2	23
Harrowing Acre unit	24.2	.87	2.1	1.39	$.14 A.	$.106 A.	$.21 A.	$.46 A.	$.13 A.	$.59 A.	1½		1¼	$.035	1.96	4.4	8
Discing Acre unit	20.3	.91	1.86	1.04	$.148 A.	$.095 A.	$.25 A.	$.493 A.	$.165 A.	$.658 A	5¾		4	$.043	6.6	14.2	27
Drawing Hay			1.25	1.67									½		.49	1.2	2
Cutting Grain Acre unit	19.6	.84	1.64	1.11	$.137 A.	$.105 A.	$.255 A.	$.497 A.	$.13 A.	$.627 A.			¾	$.012	1.22	2.8	5
Road Scraping	16 Miles	.95 per Mi.	1.54	2.07	$.155 Mile	$.204 Mile	$.31 Mile	$.67 Mile	$.213 Mile	$.883 Mile	1¼		2	$.056 per Mi.	3.43	7.25	14
Feed Grinding	14,650 lbs.	1.22 1000 lbs.	1.78	.887	$.199 1000 lbs.	$.112 1000 lbs.	$.34 1000 lbs.	$.65 1000 lbs.	$.23 1000 lbs	$.88 1000 lbs.	3¼		1¼	$.06 1000 lbs.	1.96	4.175	8
Wood Bussing	48.6 cords	.3 per cord	1.43	44	$.049 per cord	$.017 per cord	$.105 per cord	$.17 per cord	$.065 per cord	$.235 per cord	5¼		1½	$.012 per cord	2.21	5	9
Corn Husking	436 bushels	4.15 per100bu	1.8	.81	$.68 100 bu.	$.344 100 bu.	$1.15 100 bu.	$2.174 100 bu.	$.67 100 bu.	$2.844 100 bu.	2		½	$.18 100 bu.	.98	2.35	4
Average or Total			1.69 Gal. Av.	.953 Qts. Av.							24¾ Total		15 Total		2.7 Average	53.57 Total	100 Total

Depreciation and interest based on an investment of $550.00. Estimated life 5 years. Depreciation $110 yearly. Interest (6%) $19.80 yearly.

*This seemingly low acreage per 10-hour day is due to the fact that about 80% of the plowing was done in low gear.

DRAINAGE CONTROL ON MUCK LAND

On Some Muck Areas, the Proper Water Level May Be Secured by Control Dams

H. H. MUSSELMAN, AGRICULTURAL ENGINEERING SECTION

Thorough drainage placed deep is sometimes detrimental on certain types of muck soils. In some cases where it is desired to hold the water in the soil at certain seasons, control dams are placed across the outlet ditches and the flow in these ditches controlled by weirs and sluiceways through these dams.

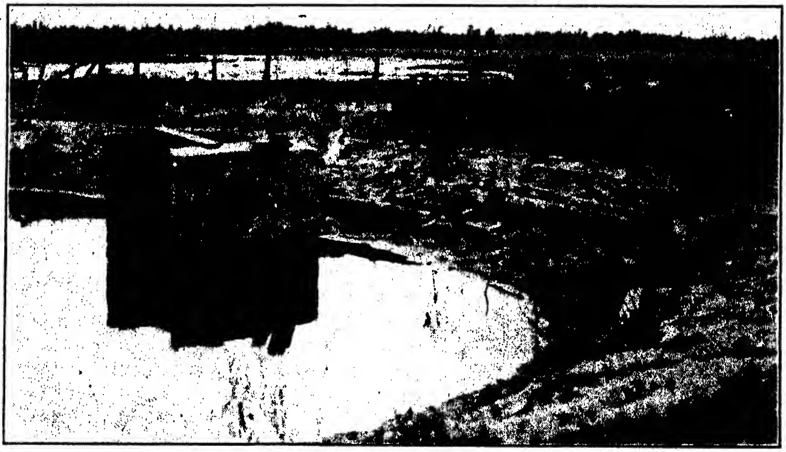

Fig. 9.—A muck dam with earth core wall showing inlet box with wooden boards inserted in recessed edges of box to control the water level of the ditch.

The construction of a dam in muck soil involves some difficulties. Water passes readily through muck and unless the foundations of the dams are laid on clay or other impervious strata, seepage may occur. Also, in the construction of the dam, muck must be used for a greater part of the fill, so that some impervious material must be used in combination with it. Where muck is underlaid with sand, careful investigation is necessary to determine whether the construction of such a dam is feasible.

Fig. 10 shows methods of overcoming some of these difficulties. Practically all of the suggestions are embodied in dams now in use.

The difficulty of passing water through the dam is met by making a sluiceway of large tile with cemented joints or galvanized culvert pipe. To control the height of water, a square control box is constructed at one end of the sluiceway. The side of this box facing upstream has recessed edges into which wooden divisions are set, closing this side and raising the water level to the desired height.

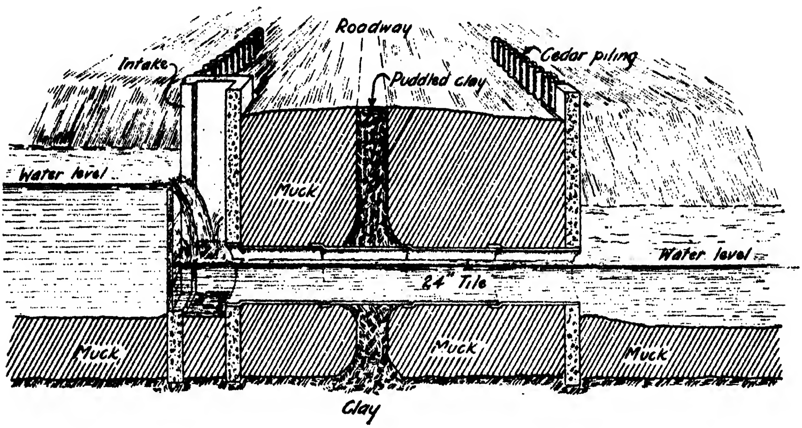

Fig. 10.—A drawing which shows a cross section of muck dam with clay core wall. Concrete intake has removable gate sections of plank for controlling the water level on the upper side of dam. Water is conveyed from the intake through the dam by means of 24-in. tile.

To prevent seepage, a wall of puddled clay a foot or more thick may be built through the center of the dam, across the stream and extending to clay or deep enough to secure effective stoppage of water. In building this clay wall, boards may be used for forms which are raised as soon as the muck or earth fill reaches the level of their tops. The clay should be wet and well puddled, which will make it impervious as long as it is protected and kept moist by the fill. Concrete could, of course, be used in place of clay at considerable more expense.

Piling of poles may be set in the muck to form retaining walls for the dam. They are not necessary but save considerable fill material.

The top of the dam, if of muck, should be of considerable width and may be made to serve as a bridge over the ditch. The size of pipe necessary to pass the flow of the ditch will depend, of course, on the width and depth of the ditch and on the head of water which it is necessary to maintain. Probably one foot should be considered the minimum diameter to use in any case.

WINTER EGG PRODUCTION

Feeding, Management, Effect of Temperature, and Cost of Egg Production at the Michigan Egg-Laying Contest

C. M. FERGUSON, POULTRY SECTION

The winter months bring high egg prices and also many conditions which are not conducive to high egg production. It is the purpose of this article to bring out some of the interesting facts gleaned from the performance of the thousand hens under test at the Michigan Laying Contest.

Heavy Grain Feeding

During the first two years, we have followed a practice of limited grain feeding during the winter months. The birds have been under artificial lights and have shown a spring slump during both years. This past winter we fed a heavier grain ration. The result shows a very satisfactory performance during the winter and with no spring slump. At the time of writing, April 10, we have a total production of 70,483 eggs since November 1 as compared with 66,738 for the winter of 1923-24, and 61,790 for the winter of 1922-23. During the week ending April 10, the thousand birds produced 3,728 eggs as compared with 2,816 eggs in 1924, and 3,228 for the corresponding week in 1923. This improvement in spring production after a period of heavy winter laying we believe to be due largely to heavier grain feeding during the winter.

Feed Prices

Feed prices, which have been very high this season, have tended to increase the cost per dozen of eggs. The following prices were used in compiling feed costs for the winter of 1924-25.

Scratch grain, composed of equal parts of wheat and cracked corn, $2.80 per 100 pounds.

Mash,—Corn Meal	30	pounds	$2.30 per 100 pounds
Ground Oats	20	"	
Bran	20	"	
Middlings	20	"	
Meat Scrap	10	"	
Salt	1	"	
Calcium Carbonate	3	"	

Milk,—Condensed Buttermilk	$3.50 per 100 pounds
Grit	$1.25 per 100 pounds
Oyster Shell	$1.10 per 100 pounds
Charcoal	$5.00 per 100 pounds

Method of Feeding

The method of feeding employed at the Contest Plant is as follows:

Dry mash mixed according to above formulae is before the birds at all times.

Grit, shell, and charcoal are also in hoppers before the birds.

Water is before the birds at all times.

Sprouted oats are fed for green feed.

Semi-solid or condensed buttermilk is fed as it comes from the barrel, pasted on a feeding board once a day.

Scratch feed is fed twice a day. One-third of the daily allowance being given the first thing in the morning and two-thirds as late in the evening as possible.

Artificial lights are used from 5 A. M., Eastern Standard Time, until daylight. No evening lights are used.

Amount and Value of Feed Consumed

The following table gives the amount of feed consumed per pen for each breed. This is based on the average consumption per pen of ten birds. If there were two reserves in a pen the total feed consumed was divided by 10/12 to get the amount consumed by the ten regular birds whose egg production appears on our publication.

Table 1. Feed Cost and Cost per dozen eggs by breeds from November 1, 1924, to February 28, 1925.

	Lbs. Grain per pen	Lbs. Mash per pen	Lbs. Milk per pen	Lbs. Grit per pen	Lbs. Shell per pen	Lbs. Charcoal per pen	Lbs. Oats per pen (gr. feed)	Val. feed per pen	Avg. No. Eggs per pen	Avg. Cost per dozen eggs cents
W Leg.	149.4	96.2	37.6	9.4	14.	3.	25.5	$8.72	513.2	20.28
Rocks	170.	106.9	29.	11.7	15.	2.1	25.5	$9.24	411.3	26.80
R.I.R.	170.	122.2	30.5	10.7	16.2	1.1	25.5	$9.91	493.09	24.01
Misc.	145.5	88.2	29.7	10.9	14.4	3.1	25.5	$7.99	455.8	21.02

Egg Sales

The eggs were sold locally. They were all graded and sold according to the United States Standard Egg Grades. The accompanying averages give, however, only the average price received for all grades by months.

November ....51 cents
December ....63 cents
January ....56 cents
February ....45.3 cents

Temperature Changes Effect Egg Production

The accompanying graph shows the range in egg production from November 1, 1924, to February 28, 1925, inclusive. This is expressed in percentage by weeks. Above the production graph are two lines showing the low temperatures for the winter months. No attempt has been

made to show the mean temperatures for this period, since it seems to be the extremely low points which affect egg production.

In studying the following graph it will be clearly seen that a prolonged period of zero or sub-zero weather had its influence on egg production. This is most noticeable when the temperature dropped during the week of December 26 to January 2. Following this cold

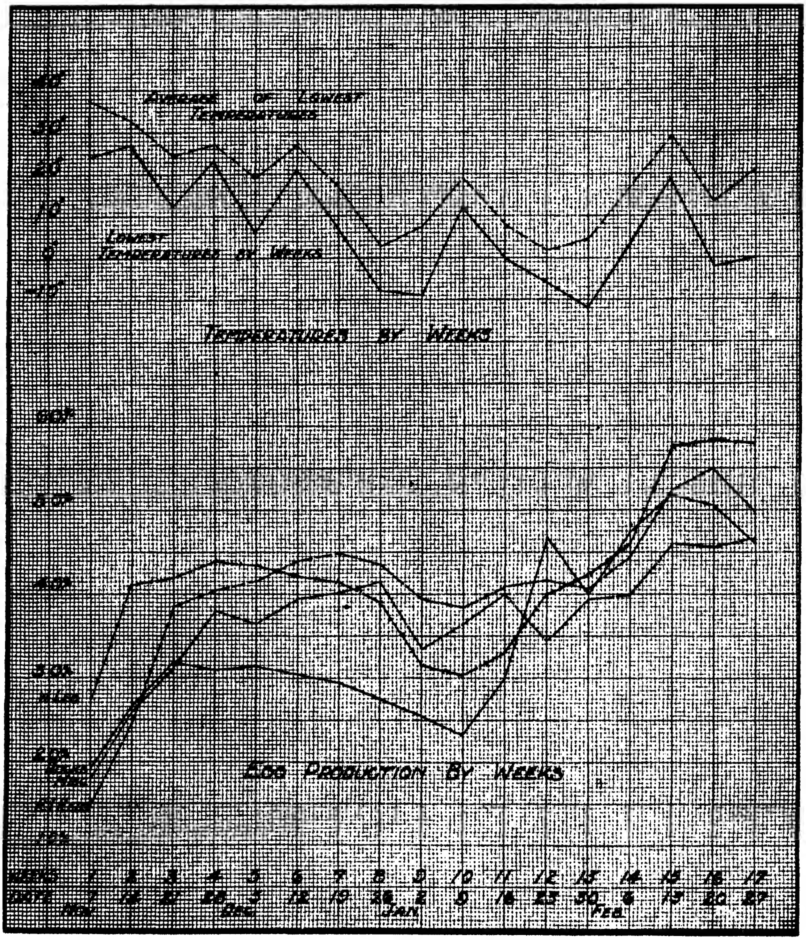

Fig. 11.—Graph showing variation in winter egg production in the different breeds under test at the Michigan Laying Contest. The lines above show the range of low temperature. The solid line indicates the lowest temperature reading for the week. The broken line represents the average of the lowest daily temperature readings by weeks.

Each line in the lower graph indicates a different breed, except the one marked Miscellaneous. This group includes three pens of Wyandottes, three of Anconas, one of Buff Leghorns and one of Brown Leghorns.

spell, production reached its lowest point. The next severe cold spell came during the week of January 30. This was not as long in duration and did not influence production as much as did the cold spell during Christmas week.

The return to zero again during the week ending February 20 again had an effect on egg production. At this time production was improving but the upward curve was checked by the drop in temperature.

It is interesting to note the performance of the different groups under these conditions.

The Rhode Island Reds and Plymouth Rocks seem to be the most consistent, dropping only 7 per cent from the week of December 19 to January 9, when they showed a recovery. The Plymouth Rock group, while not producing as well, made about the same decline as the Reds.

The Leghorn group was affected earlier in the period of cold weather, dropping from 41.5 per cent to 30.5, or 11 per cent, from the week ending December 19 to January 9, when they again showed an increase in production.

It will be noticed that the drop in the production lines follows a few days after the lowest point in the temperature readings. This undesirable effect of severe changes can be avoided on commercial plants by the use of wider houses. We find that in wider houses, 18 or 20 feet from front to rear, the birds roost further from the front and are less exposed to extremely low temperatures. The Contest houses are only ten feet from front to rear and the birds are housed in small units. This gives them greater exposure than they would otherwise have.

PLANT LATE POTATOES ON TIME

June 1 to 15 Is Usually the Best Date To Plant Late Potatoes in Lower Michigan

C. E. CORMANY, FARM CROPS SECTION

Many potato growers in Michigan are planting their late potatoes too late. Planting in late June and July for table stock is not desirable because immature and small sized tubers result. On the other hand, too early planting, i. e., in April or the first half of May, is not desirable since there is more damage by insects, heat, and drought than in later plantings. The date usually recommended for planting the late crop of potatoes in the lower peninsula of Michigan is from June 1 to 15.

The following table gives results of three years' work (1922-23-24) with Russet Rural potatoes planted at dates stated, in rows three feet apart, spaced 18 inches apart in rows, and planted 4 inches deep. The potatoes were dug by machine on the same date and graded over com-

mercial grader into three grades, namely: No. 1, No. 2, and culls. Marketable tubers includes No. 1's only.

Table 1. Summary of Date of Planting Russet Rural Potatoes—1922-1923-1924

Date of Planting	Average Yield per acre	Marketable		Average size of marketable tubers in ounces
		Per cent	Net bushel	
May 7	370.6	94.50	350.2	12.10
May 14	389.2	93.46	363.7	12.94
May 21	339.0	92.93	315.0	12.12
May 27	285.4	93.49	226.8	10.19
June 4	259.0	94.29	244.2	10.93
June 11	200.0	96.25	192.5	8.89
June 18	140.4	91.37	128.3	6.15
June 25	88.6	87.10	77.2	5.29
July 2	79.8	85.39	68.1	5.00
July 9	56.8	79.97	45.2	4.13
July 16	47.6	73.19	34.8	5.37
July 23	32.2	57.40	18.5	3.04

These results indicate that:

1—Early plantings, April and May, will constantly give greater yields.
2—Late plantings, late June and July, will constantly give lower yields.
3—Potatoes planted about the middle of June have given the best average size of tuber in the No. 1 grade. Earlier plantings resulted in many large tubers, some quite coarse. Later plantings produce smaller tubers.

Observations show:

1—That although the earlier plantings give larger yields, there is considerable loss from oversized potatoes when grading.
2—Late potatoes planted during the first three weeks in May are liable to result in a discolored condition of the interior of the tubers, due to the hot, droughty weather conditions during their formation. This condition is undesirable.
3—Early plantings are injured more by the Colorado potato beetle and the flea beetles than are the later plantings.
4—Potatoes planted the first two weeks in June give well matured tubers of a very desirable size.
5—Potatoes planted after June 10 or thereabouts do not mature fully and the skin "feathers" up badly and bruises are more serious than for earlier plantings. This injures market condition.

Seasonal influences will be great some years, but the average must be considered in drawing conclusions.

MISCELLANEOUS ROOT CROPS

Mangels, Rutabagas, Turnips, and Sugar Beets Ranked in Yielding Ability in the Order Named

C. E. CORMANY, FARM CROPS SECTION

Many farmers in Michigan who do not have silos, are interested in producing some succulent livestock feed for winter use. The various root crops are generally used. Many varieties of these have been tried by our farmers. A few of the more common varieties are being tested at the Experiment Station at East Lansing.

The one year's test made with miscellaneous root crops, including mangels, rutabagas, and turnips, indicates that they rank in the order named in yielding ability.

These roots were all planted June 12 and harvested October 16. The rows were 28 inches apart and the mangels and rutabagas were thinned to 12 inches apart in the rows, the beets and turnips to 10 inches.

The cultural practices followed were the same as for sugar beets.

Table 1. Yields of Miscellaneous Root Crops, 1924, M. A. C.

Crops and Variety.	Yield per acre—Tons.
Kirsche's Fodder Beet (Mangel)	25.94
Giant Feeding Half Sugar Mangel	24.02
Mammoth Long Red Mangel	23.87
Bangholm Rutabaga	23.84
Amber Globe Turnips	22.47
Golden Tankard Mangel	18.51
Monarch or Tankard Rutabaga	18.11
Sugar Beets (check)	17.11
Long Dark Red Garden Beets	15.02
Cowhorn Turnips	12.37

Table 2. Group Yields for 1924 are as follows:

Mangels	23.08 tons per acre
Rutabagas	20.97 tons per acre
Turnips	17.42 tons per acre
Sugar Beets (used as check)	17.11 tons per acre
Garden Beets	15.02 tons per acre

The above results are for one year only and no definite conclusions are drawn.

YIELD AND MARKET QUALITY OF POTATOES

A Discussion of Time of Planting, Seed Treatment, Green Sprouting and Cultivation and Their Effect on the Yield and Quality of Potatoes

J. W. WESTON, FARM CROPS SECTION, IN COOPERATION WITH B. W. HOUSHOLDER, G. W. PUTNAM AND H. R. PETTIGROVE OF THE U. P. STATION

The following experiments conducted at the Upper Peninsula Experiment Station apply more particularly to the potato sections of the northern part of the State. Each year, Michigan growers suffer large losses due to the poor quality of their potatoes. A great deal of this poor quality may be due to seasonal differences, but, undoubtedly, a great deal is due to poor cultural practices, lack of seed treatment, late planting, and poor seed. Quality can be improved and maintained in spite of many of the seasonal differences by the careful planning and following of approved methods.

Table 1. The Time of Planting Two Standard Late Varieties, White Rurals and Green Mountains and One Early Variety, the Irish Cobbler.

Date of Planting	Rurals 1920-21-23		Green Mountains 1920-21-23		Irish Cobblers 1922-23	
	Yield	Per cent U. S. No. 1	Bu. Yield	Per cent U. S. No. 1	Yield	Per cent U. S. No. 1
May 19	269.8	90.3	269	89.3	105.	77.8
May 26	272.4	89.9	268	88.6	93.6	92.5
June 1	232.1	91.2	247	87.5	147	76.9
June 9	235.2	90.8	235	88.2	176	84.1
June 16	235.0	87.3	261	84.0	169	82.5
June 23	188.6	85.6	175	85.0	91	73.3
June 30	123.5	72.2	128	73.8	104	64.0

The May plantings showed a tendency to produce large potatoes, but closer planting would overcome that difficulty. The potatoes were more mature, had firmer skins and were of better quality from the early plantings. The planting of June 9 gave a good yield, but the Rurals were generally immature with a slight increase in the number of U. S. No. 2 potatoes. The last two June plantings gave, generally, lower yields of immature potatoes of poor cooking quality. On account of a severe freeze on June 24, 1922, that season's results were omitted. The best time to plant late potatoes, according to the above date, would be by June 16.

The production of Irish Cobbler potatoes for seed purposes is of in-

creasing importance. The foregoing data on this variety would lead us to believe that the best yields are secured from plantings made from the first to the middle of June. For the production of early table-stock potatoes, Cormany has shown at the East Lansing Station, that Irish Cobbler potatoes produce the best quality and yield if planted before May 10. For the production of seed, Irish Cobblers should be planted in the northern part of the State, where the climatic conditions are more similar to those found at the Upper Peninsula Experiment Station.

There is a change of climatic conditions of about one degree Fahrenheit for each 100 miles north and for each 300 feet increase in elevation. On account of the influence of the Great Lakes, however, a strip of land adjacent to Lake Michigan and Lake Huron has the same length of growing period as has Lansing, 140-150 days. Cormany found that the best planting dates at East Lansing for the Rural variety was the first two weeks in June. The Michigan Plateau, which finds its greatest elevation—600 to 800 feet above lake level, at Cadillac and Gaylord, the growing season varies from 90-130 days and would take an intermediate planting date between Lansing and Chatham. Chatham has a growing period of 90 days, or less. If we are to draw conclusions from the results at the two Experiment Stations, that area in the upper and interior part of the Lower Peninsula would get the best quality and yield by planting their late potatoes the last two weeks in May and the first week in June and their early varieties for seed purposes by the 20th of June.

Table 2. Results of Five Years' Experiments Comparing the Following Cultural Practices, 1919-23 Inclusive.

Cultural Methods—Cultivating	Average Yield Bu. per Acre	Average Per cent of U. S. No. 1
Deep—Shallow	254	86.8
Shallow—Deep	205	77.5
Cultivated before Plants are up	259	82.2
Cultivated after Plants are up	257	84.6
Hilling	235	84.2
Flat	255	84.2

The experiment on cultural practices was undertaken in order to determine whether certain methods of tillage were superior to some other methods in the growing of potatoes in the northern part of the State. In the deep to shallow cultivation method, the first cultivation after the plants appear above ground was deep and as close to the plant as it was possible to go; the subsequent cultivations were shallower and farther away from the plants as they developed, cultivation being left off at blossoming time. The opposite practice of shallow to deep cultivation was tried where the first cultivations were made by simply working the top soil to kill the weeds and the last cultivation was made with a shovel plow, throwing the dirt up around the plants in a high ridge at blossoming time, or when the potatoes had reached the size of a hen's egg. The advantage of the deep to shallow method of cultivation was very pronounced, giving 49 bushels more potatoes to the acre and 9

per cent more marketable tubers. Root pruning by using the shovel plow late in the season was thought to be the main cause of the difference in yield.

Cultivation Before Plants Are Up vs. After

The practice of cultivating the potatoes several times before the plants are up was compared with waiting until the plants were up before cultivation began. The added expense for labor to remove the weeds between the hills, where the ground was not worked until the plants were up, was found to be too expensive a tillage practice to justify its use. The cultivation of the field before the plants were up practically eliminated any hand work. There was practically no difference in yield, although there was a big difference in cost of production per acre on account of the hand labor.

Hilling vs. Flat Culture

In some sections of the country it has been found more profitable to hill the potatoes early and keep them hilled throughout the season. This method was followed and the results compared with the system of cultivation which results in leaving the ground nearly flat. There is apparently enough drying out of the ridges most years to make this a questionable practice in as favorable a growing section for potatoes as the Upper Peninsula. On the heavier soils, where the retention of soil water is greater, this method of hilling hight be beneficial in keeping the potatoes out of the water at harvesting time, but on the lighter soils the level cultivation will undoubtedly give the best results.

Table 3. Seed Treatment Experiment Comparing the Use of Corrosive Sublimate to Formaldehyde and No Treatment for the Period from 1919-1923 Inclusive

Treatment	Average Results of 1919-20-21-22-23	
	Average Yield Bu. per Acre	Per cent of U. S. No. 1
Corrosive Sublimate	262	87.9
Formaldehyde	254	82.8
No Treatment	202	78.8

When corrosive sublimate was recommended in place of formaldehyde as a disinfectant against black scurf, the above experiment was started and continued for five years. Observations made on growing plants showed that corrosive sublimate insured the young sprout and growing plant a period of freedom from this trouble, apparent in the tops by a more normal growth. The increase in yield and percentage of marketable potatoes makes the corrosive sublimate treatment of seed potatoes very practical.

Table 4. Results Showing the Effect of Greening or Green Sprouting of Seed Potatoes on the Late Varieties of Green Mountain and White Rurals.

Variety	Year	Yield Per Acre		Yield Bu.
		Green Sprouted	Unsprouted	Difference
White Rurals	1916	326	261	Plus 65
White Rurals	1918	215	181	Plus 34
Average	2 Years	270.5	221	Plus 49.5
Green Mountain	1917	206	156	Plus 50
Green Mountain	1919	145	132	Plus 13
Average	2 Years	175.5	144	Plus 31.5

The practice of greening or green sprouting seed potatoes before planting to hasten the development of the plants is one commonly resorted to in older countries. It has the same effect on time of maturity of plants as the planting of unsprouted seed ten days to two weeks earlier. The sprouts developed in this way are an aid in culling seed. The stand is usually more uniform and the plants are more vigorous and thrifty than from dormant stock. This table shows an increased yield of 49.5 bushels of White Rurals and 31.5 bushels of Green Mountain per acre from this practice.

SUMMARY

Time of planting potatoes to secure the best yield and quality will necessitate more careful spraying throughout the season.

Work the land before the plants are up to kill weeds between the hills. Begin with deep cultivation close to plants and gradually work shallower and farther away as the plant develops, leaving ground comparatively flat, so that more moisture will be retained.

For cheapness, simplicity, and effectiveness, there is no seed treatment as yet which surpasses the corrosive sublimate method—4 ounces to 30 gallons of water and soak for 30 minutes. For detailed method of seed treatment, write the Director of Experiment Station, Michigan Agricultural College, East Lansing, Mich.

FROST PROTECTORS FOR EARLY PLANTING

Celluloid, Glassine, and Light Parchment Are Efficient in the Order Given

R. P. HIBBARD, BOTANICAL SECTION

Increasing interest is being shown among the truck growers and market gardeners of this state in the use of paper plant protectors. A very popular form of plant protector at present on the market is what appears to be a paraffined or oiled brown paper cone supported over the plant by two half hoops or arches of wire placed at right angles to each other. The type of protector mentioned above sells for two dollars a dozen. At the end of the season the wire parts can be gathered up and stored away until some convenient time, when they can be repapered at a cost of approximately two cents each.

These paper cones, it has been claimed, protect the plants beneath them from the late spring frosts and accordingly make it possible to start planting in the field some two weeks earlier than usual. Whether they will find wide use in this state must depend largely on experience.

Beyond the fact that these paper protectors provide a little extra heat or warmth for the plant, it must not be forgotten that they also considerably reduce the amount of light, the all-important factor in the food manufacturing operations. Plants growing under untreated brown wrapping paper cones show the characteristics of plants grown in deep shade—they are larger, paler in color and more succulent. To the uninitiated the larger growth is often wrongly taken as a sign of vigor. Ordinary cones, then, hardly benefit the plants; they scarcely do more than keep them alive. Perhaps this is the purpose of the cone, but the question may rightly be asked, cannot the cone be improved in some way? Might not better papers be found that would conserve heat and still allow better penetration of light than the papers now in use? From an economic standpoint, the price must also be kept down.

The experiments reported below were made to answer these and other questions. They were first set up in the greenhouse during the early winter months of 1924 and followed by field tests in the spring. It first seemed necessary to find out whether or not the plants beneath the protectors made as much plant material as those outside. Well selected kernels of Duncan corn were planted in the greenhouse bench. When they had germinated and were about one inch tall, the cones or protectors were placed over some, (ten as a rule) and others were left uncovered as checks. Usually, after a two-week period, the plants, minus the roots, were harvested, placed in the oven and dried to constant weight.

As shown in the table below, the plants under the cones produced less dry weight than the controls. The control plants showed an increase

Table 1. Comparative Dry Weight values of Corn Plants covered with Paper Cones and Uncovered.

Number of Experiment	Covered dry wt. Ave. 10 plants grams.	Uncovered dry wt. Ave. 10 plants grams.	Ratio uncovered to covered	Per cent Increase
1	0.935	1.170	1.25	25
2	0.779	1.174	1.50	50
3	0.465	0.580	1.24	24
4	0.355	0.555	1.56	56

as high as 56 per cent over the plants covered with ordinary wrapping paper cones. There was no exception to this rule in the various experiments performed. When a wrapping paper cone is oiled, light penetrates more readily and the increase in plant material produced cuts the difference between the control and cone from 50 to 17 per cent in one particular experiment.

One of the factors that is essential to the food manufacturing operations in plants is light, and it may very likely be this that acts as the limiting factor to the production of plant material. The amount of light under these cones is perhaps too meager, especially in the winter months, to produce the normal amount of plant material.

In the greenhouse during the winter months, the light intensity is below that suitable for the optimum growth of plants, yet, as all know, they do manage to get along and make some growth. When grown under cones, the conditions are much worse. The light intensity is reduced and can not help but interfere with photosynthesis. To determine light intensities in the greenhouse and under the cones, a well known chemical method was used. Obviously, the amount of light under each cone differed. All figures were converted to the percentage basis, using the figures representing the greenhouse intensity as 100 per cent. The following descending order of light intensities was obtained: Check, 100; celluloid, 91; glassine, 81; light parchment, 71; heavy parchment, 71; oiled paper, 64; medium parchment, 61, and brown wrapping paper, 23. These figures are an average of several experiments in the greenhouse. Under an entirely different set of conditions outside of the greenhouse, the following figures were obtained—uncovered, 100; celluloid, 93; glassine, 92; medium parchment, 83; light parchment, 80; oiled or waxed paper, 76. These figures are also an average of several experiments.

That photosynthesis has been reduced, has been shown in two ways in the experiments just reported. There has been a reduction in the light available for the food manufacturing process, and a reduction in the actual amount of plant material made. Furthermore, it is evident that light passes through the different types of paper cones at different intensities. In this respect celluloid is the most efficient, followed by glassine. Of the two, glassine is cheaper by far and is in every way suitable for field work, as will be shown in another experiment.

Before taking up a description of this work, it is desirable to study the temperature conditions under the cones and compare them with temperature conditions in the open. As might be expected, there is a

difference, which, though small, is quite appreciable. A further difference is noticed under the different types of paper cones. The temperature under the cones at 8 A. M. varied from 0° C. to 3.0° C. higher than the checks. At 12 noon, the variation was from .6° C. to 3.6° C. higher. The temperatures for the 4:30 P. M. period were all lower by .3° C. to 3.3° C.

The minimum temperatures at night were always higher under the cones, with a variation of .6° C. to 1.5° C. in this one particular experiment. The lower temperature for the 4:30 p. m. period are very likely due to the fact that at this early season (March) period the sun's rays are not sufficiently warm enough when so near the horizon to appreciably affect the temperature under the cones, although it does influence the temperature in the open. A further study of the results shows that there are appreciable differences in temperatures under the different cones. Under celluloid, the temperature is the highest, followed next by glassine. Light parchment is third, while waxed and brown wrapping paper are the lowest. These readings are all taken under cones without plants. The presence of plants would, of course, affect the temperature slightly.

The experiment was continued in the open field on a larger scale with tomato seedlings. The seedlings for this experiment were grown previously in the greenhouse from a single plant selection of the June Pink variety supplied to us by Professor G. E. Starr of this Experiment Station.

From a large supply of seedlings grown in three-inch pots, the required number of plants of the same size, color, and vigor were carefully selected and planted in seven rows, 80 feet long and 4 feet apart, running in a north and south direction. The two outside rows were used as border rows, and the five inside rows as the experimental rows, one row for each of the five different types of cones (celluloid, glassine, light parchment, medium parchment, and waxed or oiled paper). Alternate plants in each row were covered by cones, while the plants remaining were used as checks. There were then ten plants under cones and ten plants without cones in the same row. Two weeks after planting, when it was assumed that the tomatoes had become established to field conditions, the cones were put over them and the stand of tomatoes was at that time uniform. The cones were taken off at the end of another two-week period. At this time one could notice a difference in size and also in color. Each plant, the roots not included, was bagged and labeled, taken to the laboratory and placed in a drying oven and dried to constant weight. All the check plants, or those uncovered, in each row were treated likewise. The dry weight of the individual plants was taken as the criterion of growth, or plant material made under the various conditions.

The air temperature under the cones varied, but the greatest variation did not go beyond four degrees C. During the warmest part of the day the temperature under the celluloid cones was 3 degrees higher than the check. Then followed medium parchment, with an average of 1.7° C. higher than the check. The third was glassine and the fourth light parchment. Waxed or oiled paper was no better than check. These data correspond quite closely with those in the laboratory experiments.

Just before harvesting the plants, a few general observations were

made. In nearly every case the plants grown under cones were larger than the controls around them, and especially was this true in the case of plants under the glassine and celluloid cones. It was further noticed that the plants growing under cones made of medium parchment, light parchment, and waxed or oiled paper were a pale green in color instead of a bright green, as under the glassine or celluloid cones.

In considering the results of the field experiment, the conclusions were drawn from the figures representing the dry weights of the individual plants, and not from the green weight, height of plants, blossoming or any other general characteristic. The data obtained from the border rows were excluded, as is generally customary. The figures, then, of the five inside rows form the basis of our conclusion and the results have been treated statistically.

Since nothing less than 3.2 times the probable error or odds of about 30 to 1 are generally considered significant the conclusion may be drawn that under none of the different types of cones did we have conditions more conducive to growth than in the open. At no time during the experiment did a frost occur, and this is probably one of the reasons why a greater difference between the check and cone plants did not occur. The spring was late and the plowing and preparation of the seed bed was much delayed over the customary time. And again, although the statistical treatment showed no significant difference, the plants under the celluloid and glassine cones looked better, and the color was the natural healthy green of the checks. The plants growing under light parchment, medium parchment and waxed paper cones were a pale green to yellow color. When the results were calculated in the customary way, the increase in dry weight of plants under the glassine cones over that of the checks was 17.6 per cent. For plants under celluloid cones the increase was 17.3 per cent. Under the waxed paper cones the increase was the lowest of all, 6.3 per cent. The glassine or celluloid results are almost three times as great. Celluloid, however, is expensive, while glassine is cheap and such cones could be made for about $1.50 a dozen. The glassine cones withstand the climatic conditions of the early spring just as well as the waxed paper cones, which we consider very efficient in this respect.

In conclusion, then, these studies seem to show that either in the greenhouse or in the field, there is no significant increase in the production of plant material under the cones as compared to the controls, from a statistical standpoint. This is probably due to variations in soil conditions. The intensity of light is reduced and the temperature slightly raised. All the different types of cones, judged from dry weight data, affected plant growth differently. Plants under celluloid developed better than those under waxed paper. Glassine followed second, with practically the same influence. Light parchment was third. All of these were better than the waxed paper, even though when the data were treated statistically the odds were not quite large enough to make the differences significant.

THE HORSE SITUATION

A Discussion of the Past, Present, and Probable Future of the Industry

RALPH HUDSON, FARM AND HORSE DEPARTMENT

There is a great deal of discussion at the present time in regard to the supply of horses, and many predictions are being made as to the future of the industry. Most of the published data have come from reliable authorities and may be taken as fairly indicative of the true condition of the horse industry.

A brief summary of some of these reports may be of advantage to the man who is more or less uncertain as to whether to breed his mares this spring or to continue to buy at the country auction. A few years back, and even at the present time, a farmer has been able to buy horses at a lower price than he could produce them, and so long as this can be done, breeding operations will be carried on in a very limited way and only by the man who has a liking for the work or by the man who can see a little farther ahead than most of his neighbors.

Before the World War, imports of breeding animals into the United States were numerous. Since the war, this trade has practically ceased,

Fig. 12.—Belgian mare, Pervenche, and foal, one of the seven mares with foals at the College, spring, 1925. Six more mares will foal soon. Pervenche was the 1923 and the 1924 Grand Champion Belgian mare at the International Livestock Show at Chicago.

due largely to the manufacture and use of automobiles, trucks, and tractors, and to the argricultural depression which has existed since that time. A big surplus of horses existed at the time of the war, the horse population at that time being greater than ever before in the history of the world. The war, along with an almost complete curtailment of breeding operations, has rapidly diminished, and, in fact, has used up this surplus.

In the United States, the number of horses has diminished from a total of approximately 21,500,000 in 1918, to 17,500,000 in 1925, a decrease of 3,961,000 head. The number reported for 1925 is practically the same as the number reported twenty years earlier, or in 1905.

In Michigan, the condition is practically the same. The number of horses continues to decrease annually. Very few colts are being raised and the average age of all horses is much higher than it was a few years ago. The estimated number is 542,000, as compared with 570,000 for one year ago, a decrease of 28,000 head, according to Verne H. Church, statistician, U. S. D. A. and State Department of Agriculture. Figures were recently obtained from 97 of the Short Course Students taking the winter courses in Agriculture at M. A. C. These students came from Michigan farms and undoubtedly from farms being well managed. The 97 students represent 17,445 acres, 11,347 acres of which is cultivated land. A total of 440 horses, or one horse per 25.8 crop acres, is kept on this land. Of the 440 horses, 196, or 44 per cent, were over ten years of age; 26 head, or 6 per cent, were under two years of age, and the remainder, 218, were in middle life or probably approaching the years when they are depreciating in value. Of the 440 head, only 23 mares will foal this year. At this rate of breeding, it will take nearly twenty years to replace, by production, the horses on 97 of Michigan's better farms.

Michigan has never been a horse-producing state, but rather a buying state. Weekly reports for the spring from the Chicago market indicate heavy movements of horses into Michigan and Wisconsin. The other states are in much the same position as Michigan. They have not been breeding horses. The mortality in horses since 1919 has been greater by several thousands than the births in horses. In 1923, Iowa was the only state in the Union with a surplus. In one year that number decreased 25,000 head.

To the man in Michigan who wishes to get away from the rather unsatisfactory market condition by breeding and raising his own horse power, the greatest obstacle is a shortage of good stallions.

In 1924, Michigan licensed 615 stallions. To date, the number is far below this figure and the Department of Agriculture at Lansing, in charge of stallion enrollment work, predicts a decrease of 200 in this number. This means, then, five stallions to a county, if they were evenly distributed. In Iowa, the leading horse-producing state, there has been a decrease of 28 per cent as compared with the number kept in 1914, when the number was greatest.

According to a recent report, there were 15 per cent fewer horses marketed in the sixty-seven horse markets of this country in 1924 than in 1923. The mule is gaining rapidly on the horse in popularity in many sections. At Kansas City, the market has shifted from 65 per cent on horses and 35 per cent on mules, to 85 per cent mules and 15 per cent

horses. St. Louis is receiving twice as many mules as horses. These markets are largely clearing houses for central southern trade, where the mule is supplanting the cheaper grade of horses handled by the leading markets. Since the supply of good mules is entirely dependent upon the horse, the condition should not discourage horse breeders.

That horse power is still more economical than motor power for some kinds of city work, especially for short hauls and frequent stop work, is being proved daily, according to figures being published by milk, coal, ice, and similar delivery firms. There are, however, other influences than economy that are working a hardship for the horse, and which are somewhat unfavorable to an increase in his use.

The slow speed at which he travels, and the element of danger caused from slowing up in the tide of traffic on streets or roads crowded with motor vehicles, is making him somewhat unpopular in these areas.

That we have been passing through a period of adjustment, there is no doubt. Many city firms that completely motorized their equipment later turned back to horses, finding horse delivery more satisfactory and costs cheaper. Others, and these seem to be in the majority, are using motor equipment for a part of their work and horses for a part. In other words, they are classifying their work, using motors in lines where they work with the greatest satisfaction and economy, and the horse at other duties where he can work more efficiently than mechanical power.

The farmer has been passing through a similar period. He has found that he cannot motorize completely in most cases. On larger farms, where conditions are favorable for tractor use, a tractor has been found to form a very necessary part of the equipment. No longer, however, is the tractor salesman trying to convince the farmer that he can sell all of his horses and do his work with a tractor. One can realize fully the amount of work done by the horse and the variety of tasks to which he is adapted, by driving through the country during the spring of the year when farmers are in the field. The vast number of small farms, the topography of the fields, the variety of soils and crops, and the number of boys, women, and aged men doing the work all tend to make one feel that the horses will always form the greater source of farm power equipment.

That the city will always have jobs for high class pairs of horses in quantities that the future will produce, there is no doubt. A recent market report states that buyers are always standing in line for the tops and that they are taken away at private treaty before passing through the auction. A report also states that Michigan and Wisconsin are buying freely; that there is a shortage of horses on corn belt farms, and that eastern farm demand is in full swing.

That the farmer breeder should no longer plan on a city market for large numbers of common draft horses, is evident. However, the horse has a safe corner in this world and it would appear that in a short time we will pay good prices for suitable animals to fill that corner. There is no doubt but what that corner is the farm. Surely it is sensible to advocate that the best market for the horse breeders of the future is the farm itself, where there is need for a cheap anl reliable power which can be fed from the farm itself and will contribute to the fertility of that same farm. The main outlet for work horses under 1,500 pounds

will be to the farmers who do not raise their own work animals. The farmer who wants such chunks wants them cheap, often so cheap that the farmer who produces them loses money. It will save future disappointment for the man who produces the cheap kind to realize that he must either keep them until they die or produce them at a loss.

For fifteen years, Wayne Dinsmore, of the Horses Association of America, has urged keeping teams stair-stepped in ages, and holding production down to actual needs. Under his plan, mares will be bred to raise a pair of colts each year, begin working these colts at two years old coming three, selling them at five to seven years of age, and not allowing them to depreciate in value on your hands. The men who have followed this general farm policy seem to have made money on their horses. In view of the shortage which the figures seem to indicate we are facing, the farmer who has facilities and the liking for horse production should plan to adopt a system of this sort. Quoting Dinsmore again: "The man who owns poor horses and mules, who never can get good prices and is always cursing the horse business, is the man who would help the business by staying out of it."

The idea that the tractor will entirely replace the horse on the diversified farm is an illusion. The tractor will never do more than supplement the horse under these conditions. Since 1920, horses have been dying rapidly of old age and many of them have not been replaced. The next five years are likely to see further great reductions in the number of horses. Many farmers who might prefer horses will be forced into motor farming. It means much higher prices for good horses and a boom in power farming. When once the number of horses drops below the number required for farm needs, and figures seem to indicate that the bottom has been reached, it will be five years at least before a start can be made to correct the shortage.

The man on the farm should give serious consideration to this condition with an eye to the effect it will have upon his plan of farming. Horse production should be given consideration, providing it fits in or can be made to fit in well with the general farm plan. Breed for replacements at least, not going into the business with the idea of making a lot of money.

CHRYSANTHEMUM YELLOWS

A New Disease in the Greenhouse

RAY NELSON, BOTANICAL SECTION.

A disease has appeared recently in the glasshouses affecting all varieties of chrysanthemums that shows great similarity to Yellows, a disease long familiar to the growers of asters out of doors. The disease had

not been conspicuous in commercial houses until the season of 1924. Its appearance at this time was sudden and led to some confusion and considerable speculation among growers of these flowers. It has seemingly not caused any serious alarm, probably because the growers are not aware of the nature of the disease and also because of the comparatively few plants affected. On account of the possibility of this disease becoming a menace to chrysanthemum culture, this article is written to familiarize growers with the trouble and to indicate methods of prevention and eradication.

A similar disease has long been known as one of the most serious troubles affecting asters out of doors. In years when conditions are favorable to its development it is a scourge that sweeps like a plague through the plantings. Where the yellows disease occurred, the season of 1924 will be remembered by all growers of asters as an almost complete failure. In Michigan not a single planting of this flower was seen by the writer that was free from the disease, and so completely were the plantings infected that it was a rare thing to find a normal flower. The close relationship of asters and chrysanthemums and the almost complete identity of symptoms makes it probable, although not yet proved by experiment, that we are dealing with but one disease. If it is true, the widespread occurrence of the trouble out of doors on asters probably accounts for its invasion of glasshouses and attack of chrysanthemum plantings.

The disease can be recognized with certainty only at flowering time. This is not because the plant becomes diseased at this time but because of the obsecure nature of the symptoms on other parts of the plant. Affected flowers present a curious appearance. Regardless of the normal color of the variety, diseased plants produce flowers that are a sickly green color. This green color of the blooms distinguishes this disease from all other troubles that affect either asters or chrysanthemums. This transformation of color in some of the flowers, has led hybridizers and growers to believe the plants were producing sports and that a new color novelty had been produced. At the Cincinnati show varieties were exhibited affected with this disease. The entire flower may not show the green color. Half of the flower may be green and the other half of the blossom the normal color of the variety. Thus we may find a flower that is half white and half green, half yellow and half green, etc., or the green area may be in greater or less proportion of the whole blossom.

Plants that become infected with the disease early in the season usually produce only diseased flowers. On the other hand many plants produce both normal colored blossoms and those showing the green color of Yellows. On the branching types, like the pompom and button varieties, this one-sided infection is very common, while in the standard large flowering, single stemmed sorts, the disease, of course, affects the one or more flowers that develop.

The foliage of badly diseased plants is affected in varying degrees. The disease can be recognized on asters before the flowers are produced by the sickly, yellow color of the foliage. The shoots that are produced on badly diseased plants are spindly, usually shortened and more numerous than those found on normal plants. On chrysanthemums this effect

on the foliage and shoots is not so noticeable. There is usually only a slight yellowing of the foliage. One symptom, although not restricted to plants affected with the Yellows disease, is a burning and browning of the edges of the leaves. This does not alone serve to identify the disease, but plants showing this effect should be viewed with suspicion, especially in the absence of definite fungous disease on the leaves or in the roots.

There are various other symptoms that accompany this disease but they are mostly of interest from the scientific standpoint rather than to the growers. One interesting thing is the failure of diseased plants to produce seed. This sterility of diseased plants eliminates the possibility of seed transmission being important in the spread of the trouble. No experimental work has demonstrated that the seed when produced on Yellows plants gives rise to diseased plants. Aster growers sometimes report that certain lots of seed produce clean plants while others grown from another lot are diseased. This is probably due to other factors and not to transmission of the Yellows through the seed.

The cause of the Yellows disease is still unknown. Researches of recent years have revealed many interesting facts concerning diseases of this type. The disease on asters was called Yellows because of its resemblance to Peach Yellows, the most feared and destructive of all diseases affecting this tree. The name Yellows describes a prominent symptom, that is, a yellow condition of the foliage. There is probably no relationship between peach Yellows and aster Yellows other than the similarity of symptoms and behavior of affected plants.

The Yellows disease belongs to a group of plant disorders (the Mosaics) that are the most interesting and in many cases the most serious of all plant diseases. These are known as virus diseases, so called, because the organisms which cause them are supposed to be ultra microscopic, that is, too small to be detected with the microscope. They are thought to be analogous to certain human diseases, like smallpox, etc.

One of the most interesting things learned about diseases like Yellows and similar troubles, is that they are disseminated by certain insects, particularly the plant lice or aphids. On nearly all susceptible plants are found certain species of these lice which, after feeding on a diseased plant are then able to carry the same disease over to healthy plants. These insects are largely, if not wholly, responsible for the rapid spread of Mosaic diseases in seasons favorable to their development. The probable history of Yellows is that it lives over winter in susceptible perennial plants and that insects attack these in the spring and then travel to the aster plants when they are set out and thus establish the disease. It is further spread throughout the season by the multiplication and migration of these insects. In the East it has been found that the insect chiefly responsible for the spread of aster Yellows is one of the common leaf hoppers (Cicadula sex-notata). This same insect may be found important in other sections also.

In controlling the Yellows disease in the greenhouse several things must be kept in mind. *First,* that the disease is perennial in chrysanthemum plants and that cuttings taken from diseased plants will also have the same trouble. Therefore, all plants showing any symptoms of Yellows should be destroyed as soon as detected. Frequent inspection

while the plants are in flower will insure detection of any diseased plants. *Second,* insects spread the disease in the greenhouse as well as out of doors. Insects may also bring the disease into the houses after becoming infected by feeding on perennial or annual hosts out of doors.

Frequent fumigation with nicotine will keep down aphids and also leaf hoppers, probably the chief offenders. Insects should also be controlled out of doors by growers who produce plants for sale in late summer. The disease may become established in plants that are growing in the field and this probably accounts for some of the disease that was present in the houses the past season.

VOLUME OF SUGAR MAPLE TREES

A. K. CHITTENDEN, FORESTRY SECTION

The following volume table is for sugar maple trees. It gives the volume in board feet for average trees, based on two factors, diameter breast high or four and a half feet above the ground, and merchantable length of the stem. By merchantable length is meant the length which can be used for logs. The volume is given in board feet by the Scribner log rule. The top diameters, inside the bark, are given in the next to

Volume Table for Sugar Maple, in Board Feet, Scribner Log Rule

D. B. H. Inches	Merchantable Length, Feet						Top Diameter Inches	Basis No. of Trees
	24	32	40	48	56	64		
10	44	60					8.6	19
11	48	68	80				9.1	20
12	53	76	95	112			9.3	32
13	62	87	113	136			9.7	37
14	75	104	132	161	196		10.1	38
15	93	123	156	189	227		10.4	47
16	114	147	184	220	259	293	10.8	48
17	141	174	215	255	294	335	11.2	63
18	171	205	250	295	336	378	11.7	57
19	203	239	288	336	377	424	12.1	36
20		277	329	380	424	473	12.6	30
21		319	372	425	474	527	13.2	46
22		363	418	473	529	586	13.8	50
23		408	467	525	588	650	14.5	36
24		455	519	583	651	722	15.2	44
25		503	574	644	721	804	16.0	28
26		550	634	712	798	899	16.9	25
27			694	787	879	999	17.8	24
28			756	867	967	1108	18.9	13
29			821	951	1061	1220	20.1	10
30				1040	1159	1335	21.3	8
31				1130	1258	1453	22.6	7
32					1357	1571	23.9	9
								725

the last column. The data used in compiling this table was collected in the central part of the state by the Forestry Section of this Station.

The table should be accurate for large numbers of trees or for an average tree. It will not be accurate for individual trees unless the top diameter happens to coincide with that given in the table.

To use the table, the diameter at breast height, or four and a half feet above the ground, outside the bark, should be measured or estimated in inches and the length of the stem which can be used for saw logs estimated in feet. The heights are in multiples of eight, as this is as close as heights can ordinarily be estimated.

THE WOODLOT TAX ACT

The Results of This Act as Observed on Ten Woodlots in Oceana County

BY KARL DRESSEL, FORESTRY SECTION

In 1911, the Legislature passed a law known as the Woodlot Tax Act. This, as revised and simplified in 1917, provides for the reduction of the valuation of the woodlot to $1 per acre, under certain conditions. The woodlot is then taxed at the prevailing rate of the township in which it is located. The act requires that the woodlot be part of a working farm and it can not exceed a certain area, depending upon the size of the farm. Use of the woodlot for grazing purposes is prohibited and the owner must plant trees if needed to keep the woodlot fully stocked. When timber is harvested, if not used by the owner or his tenant, a five per cent tax is levied on the stumpage value of the timber cut.

Up to the present time, few farmers have made application to have their woodlots listed under this act. There are several explanations for this apparent lack of interest among woodlot owners. Some are loath to apply because of the prohibition of grazing, and others fear that the valuation of the remaining acreage of their farms will be raised. Because of lack of publicity, few farmers are even aware that there is such a law in effect.

It may be of interest to see how this law has worked out in one county of the state. In Oceana County, up to the present time, ten woodlot owners have made application to have their woodlots listed under this act. Nine of them have been accepted, one being rejected because of lack of proper description of the property as required by the law.

Of the nine accepted woodlots, one is located in Weare, two in Elbridge, two in Hart and four in Shelby townships. In real estate values these townships rank first, second, third and fifth in the county. Thus, the woodlots coming under the act are located in townships with the higher land values and the denser population.

There is a total of 171 acres of woodlots listed under the act in this county, ranging from 5 acres to 68 acres, individually. In 1922 the county had a total of 23,927 acres in farm woodlots on 2,838 farms.

There is, therefore, only a very small percentage of the woodlot area of the county listed under the act.

The owner of the woodlot in Weare Township, who has a woodlot of 16 acres containing some merchantable trees, reports that his taxes have been reduced and that the law is working out satisfactorily in his case. This woodlot came under the act in 1922.

The history of one of the woodlots in Elbridge Township is as follows: The farmer-owner placed the woodlot under the act in 1921. This man sold his farm and woodlot to the present owner, who started to harvest the trees without knowing it was under the special act. The present owner then became subject to the five per cent cutting tax and as a result had the woodlot taken from under this tax act. The following information was obtained from the tax records in the county treasurer's office: The valuation on the farm and woodlot in 1920 was $2,400 and this was reduced to $2,015 in 1921, a reduction of $385. A farm adjoining this one, but without a woodlot under the act, showed a valuation in 1920 of $2,100 and in 1921 of $1,800. Thus, there was also a reduction in valuation in this case, but the woodlot whose owner had listed it under the act was assessed at $85 less than that of his neighbor, who had not listed his.

The owner of the woodlot coming under the woodlot tax act in Elbridge Township reports a 20-acre woodlot with a few merchantable trees. There seems to be little difference in the taxes since he took advantage of this act in 1920. Again, let us turn to the tax records in the township. The valuation of farm and woodlot in 1920 was $3,400, and after listing the woodlot in 1921 the valuation was $2,620. This is a reduction of $780 in valuation the year the woodlot came under the act. An adjoining farm, not under this act, showed a valuation in 1920 of $4,400 and in 1921 of $5,000. This is an increase in valuation of $600 against a drop in valuation of $780 on the farm and woodlot of the farmer under the tax act.

In the township of Hart there are two landowners under this act, with replies as follows: One was under a partnership which is to be dissolved and the property divided, so the woodlot will be withdrawn from under the act. But the owners claimed the act had reduced their valuation and they had derived some benefit from it. The owner of the other woodlot states that he has a 16-acre woodlot clean cut in 1902 except for a few seed trees, pastured until 1908, and placed under the act in 1922. The act did not lower the taxes very much and the valuation on the rest of the farm was not raised. The county treasurer's records show a valuation of $4,800 in 1922 and $4,700 in 1923, or a reduction of $100. An adjoining farm showed a valuation of $5,000 in 1922 and this was the same in 1923. Thus, the valuation was reduced $100 on the woodlot farm under the act, while the neighbor's valuation remained the same.

In Shelby township, three woodlot owners have taken advantage of the act. One owner writes that the supervisor of the township, at the time the woodlot was accepted under the act in 1920, forgot to reduce the valuation, so that he has been paying full taxes. The supervisor acknowledged he forgot to lower the valuation. But the county treasurer's records show a valuation for the farm and woodlot of $6,500 in 1920 and $7,020 in 1921. For a neighboring farm in the same section

the county treasurer's books show a valuation of $3,000 in 1920 and this was the same in 1921. Thus, on the farm with the application for the exemption of a 20-acre woodlot, the valuation was raised $520, while the neighbor's valuation remained the same.

Another owner in Shelby Township who has a woodlot under the act states that the woodlot consists of 8 acres, being part of a 60-acre farm, with maple and beech predominating, with some of it merchantable as logs and cordwood, and that the act is working satisfactorily and has reduced his taxes. The woodlot was listed in 1920. The county treasurer's books show a valuation in 1919 of $3,850 and in 1920 of $3,600. A neighboring farm in the same section shows a valuation of $2,550 in 1919 and the same in 1920. Thus, there was a reduction of $250 in the valuation on the farm with the woodlot listed under the act.

The other owner in Shelby Township whose woodlot came under the act in 1920 reports it has not reduced the valuation sufficiently to pay. His woodlot consisted of a five-acre tract in which maple predominated, some of the trees being merchantable as logs and stovewood. The county treasurer's records show a valuation of farm and woodlot in 1919 of $3,600 and in 1920 of $3,300. A neighboring farm, with woodlot not under the act, showed a valuation of $3,900 in both 1919 and 1920. Thus, the records show that the valuation of the farm with the woodlot classified under the act was reduced $300, while the neighbor's valuation remained the same.

1925 SPRAY CALENDAR

A new spray calendar of interest to all fruit growers in Michigan has recently been published as Special Bulletin No. 140 by W. C. Dutton, R. H. Pettit, C. W. Bennett, and H. A. Cardinell, of this Station. The method of presenting the information in this bulletin is somewhat of a departure from our former spray practice bulletins. Special directions are given for the spraying of apples, pears, plums, peaches, grapes, currants, gooseberries, raspberries, dew berries and non-bearing orchards. Copies of this bulletin may be had upon request to R. S. Shaw, Director, East Lansing, Michigan.

MARKETING MICHIGAN POTATOES

A new bulletin of special interest to all potato growers has recently been published by the Michigan Agricultural Experiment Station. This bulletin is known as Special Bulletin No. 137, "Marketing Michigan Potatoes" by J. T. Horner. It considers the production of potatoes in Michigan from the standpoint of quality and efficiency. A discussion of Michigan potato markets includes the quantity of potatoes sold, where they are sold and the competing sections. The co-operative marketing associations and potato dealers are also considered. The factors influencing the prices as well as the methods of increased profits are given an important place in the bulletin. Copies of this bulletin may be obtained from R. S. Shaw, Director, East Lansing, Michigan.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, East Lansing, Michigan.

LIST OF AVAILABLE BULLETINS

Regular Bulletins—

251 Insects of 1907.
258 Insects of Field Crops.
262 Suggestions on Planting an Orchard.
264 Second Report of Grade Dairy Herd.
267 Michigan Weeds (only to libraries and teachers).
273 Utilization of Muck Lands.
277 Studies in the Cost of Market Milk Production.
281 Trees, Shrubs and Plants for Farm and Home Planting.
284 Some Information and Suggestions Concerning the Use of Phosphorus.
286 Studies and Cost of Milk Production—No. 2.
289 Corn Growing in Michigan.
290 Soil Fertility.

Special Bulletins—

58 Foul Brood.
65 Hog Cholera and Preventive Treatment.
67 Onion Culture on Muck Lands.
70 Michigan Agriculture, Its Present Status and Wonderful Possibilities.
71 Studies in the Range and Variation of the Percent of Butter Fat in the Milk of Individual Cows.
72 Some Ginseng Troubles.
74 Analysis of Some Materials Sold as Insecticides and Fungicides.
76 Transferring Bees.
79 Michigan's Shifting Sands; Their Control and Better Utilization.
80 Yellow Rocket (a dangerous weed).
81 Tomato Leaf Spot.
82 Durability of Concrete Drain Tile No. II.
83 Key to Orthoptera of Michigan.
84 Strawberry Culture.
90 Special Report of the Upper Peninsula Experiment Station.
91 Some General Information on Lime and Its Uses and Functions in Soils.
94 The Financial History of a Twelve-Year-Old Peach Orchard.
95 Muskmelon Culture in Michigan.
98 Vinegar.
99 The Detroit Commission Plan of City Milk Administration.
100 Soy Beans.
101 Oats in Michigan.
103 Forest Planting in Michigan.
104 Soils of Detroit Area.
105 Rosen Rye.
106 Sugar Beet Growing in Michigan.
107 Diseases of Bees in Michigan.

108 The Robust Bean.
109 Dependable Michigan Crop Varieties.
110 Special Report of the Upper Peninsula Experiment Station.
111 Studies in City Milk Distribution.
116 The Agriculture of the Upper Peninsula of Michigan.
117 Potato Growing in Michigan.
118 Pruning Fruit Trees.
119 The Septic Tank and Sub-Surface Tile Sewage Disposal System.
120 The Microscopic Identification and Determination of the Specific Ingredients in Stock Feeds.
121 Grape Production in Michigan.
123 Second Growth Hardwood Forests.
124 The Colormetric Hydrogen-ion Determination as a means of Locating Faulty Methods at City Milk Plants.
125 Michigan Potato Diseases.
126 An Analysis of the Peach Variety Question in Michigan.
127 Nitrogen-Carrying Fertilizer and the Bearing Habits of Mature Apple Trees.
128 Sandy Soils of Southern Peninsula of Michigan.
129 Bean Growing in Michigan.
130 The Clovers and Clover Seed Production in Michigan.
131 Tomato Growing in Michigan.
132 Field and Garden Insects.
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135 Seasonal Management of Commercial Apiaries.
137 *Marketing Michigan Potatoes.
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142 *Grafting in the Apple Orchard.
143 *Winter Pruning the Black Raspberry.
144 *Spraying Dewberries for Anthracnose.

Circular Bulletins—

28 The Bean Maggot in 1915.
34 More Wheat for Michigan.
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AGRICULTURAL EXPERIMENT STATION

MICHIGAN STATE COLLEGE
Of Agriculture and Applied Science

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East Lansing, Michigan

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ISSUED DURING

FEBRUARY, MAY, AUGUST
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CONTENTS.

EDITED BY

R. S. SHAW AND E. B. HILL

CONTRIBUTIONS BY ALL SECTIONS OF THE
EXPERIMENT STATION

MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN
Vol. 8, No. 1, August, 1925

FRANK AZOR SPRAGG

BY H. M. BROWN,* FARM CROPS SECTION

The death of Professor Frank A. Spragg, in an automobile accident on August 12, 1924, caused the country to lose one of its foremost plant breeders and Michigan one of her most loyal and useful citizens. From the time he became a member of the staff of the Michigan Agricultural College and the Michigan Experiment Station in October, 1906, Professor Spragg gave unreservedly of himself to the work of producing varieties of small grains and other crops which would be better adapted to Michigan conditions. This persistent desire to produce more desirable strains, together with his native ability to reason clearly and to select the better types of plants, were large factors in the successes which attended his labors.

Professor Frank Azor Spragg

Frank A. Spragg was born on a farm near Hazelton, Iowa, on August 21, 1874. His father, Ezra Spragg, came from New Brunswick, Canada. His mother, Anna Westcott Spragg, was of English descent. In 1880 the family moved from Iowa to Bozeman, Montana, by the popular and customary mode of travel—the covered wagon. There the father operated a saw-mill for several years. In 1884 he filed on land near Denton and in 1887 moved his family onto the ranch. There the father died on January 5th, 1897. Frank attended the grade school in Denton and obtained his high school education in Lewistown. He was in the first graduating class from the latter school. During those early years he underwent all the rgiors of frontier life from rounding up cattle on the open range to fighting the winter gales to and from school in the distant small town. In the later nineties, Frank entered

*As a graduate student of the late Professor Spragg and an assistant in plant breeding, Mr. Brown is well qualified to write intimately of Professor Spragg's life and achievements.

the Agricultural College at Bozeman, Montana. By dint of hard work, continued application, and a determination to have a college education, the raw ranch boy graduated from the Agricultural course with the B. S. degree in 1902. During these years, his partner, Brundage Kierstead, helped Frank's mother on the home ranch and also helped Frank through college.

Through the efforts of one of his teachers, Prof. R. S. Shaw, Frank was put in charge of the Montana Agricultural Exhibit for the St. Louis World's Fair. That charge, which lasted for the duration of the Fair, was a veritable open door to the ex-ranch boy. At the close of the Fair, Dean Shaw, who had moved from Bozeman to the Agricultural College at East Lansing, Michigan, invited Mr. Spragg to come to East Lansing. He entered the graduate school in the Department of Farm Crops and obtained his Master of Science degree in 1906. On October 1st of that year he became a member of the college and experiment station staff in the capacity of Instructor in Farm Crops and Expert in Plant Breeding. At his death, Mr. Spragg held the ranks of Associate Professor and Research Associate in Farm Crops, Plant Breeder, and Cooperator with the United States Department of Agriculture.

On September 9th, 1909, Mr. Spragg married Miss Volo Glenn Mills, with whom he had become acquainted while she was attending the Michigan Agricultural College. To them were born three boys, Frances, Brundage, and Glenn, and a daughter who died in infancy.

Professor Spragg interested himself not only in his work on the station but also in civic affairs and backed all propositions leading to the maintaining of a high educational and moral plane in the community. He was one of the charter members of the East Lansing, Michigan, People's Church, and for the eight years prior to his death was the treasurer of that organization. He carried his ideals of thoroughness and exactness with him into this financial responsibility, and achieved marked success.

His interest in the lines of endeavor in which he was working caused him to become affiliated with many scientific societies and organizations. Thus it came about that he was one of the charter members of the Michigan Experiment Association. This group of grain growers reorganized in 1917, as the Michigan Crop Improvement Association and elected Professor Spragg as one of the directors, a position he held until his death. In 1912 he became a life member of the American Genetic Association and the same year was elected to membership in the Michigan Academy of Science. In the latter organization he held the office of vice president of the Section of Agriculture, during the year 1918-1919. In 1913 he was elected to membership in the American Society of Agronomy and in the American Association for the Advancement of Science. In 1918 he became a Fellow in the Association, and in the spring of 1924 a Life Member. The Botanical Society of America elected him to active membership in 1917. The same year he became a Mason. The honorary botanical fraternity of Seminarius Botanicus received him as an honorary member in March, 1919. In March of 1924 he became a life member of the American Association of University Professors. In May of the same year he was elected to alumni membership of the Montana State College Chapter of Phi

Kappa Phi. That spring, while taking work at the University of Michigan, he was elected to membership in the honorary scientific fraternity of Sigma Xi. Professor Spragg was for several years a member of the American Bible Society and of the Michigan State College Chapter of Phi Sigma.

Professor Spragg's ability may best be judged by what he did rather than by what he wrote or what may be written about him. In 1911 two strains of oats, the Worthy and the Alexander, were released to Michigan's farmers. This was followed in 1912 by the now nationally known Rosen Rye. Red Rock Wheat, "the highest in bread baking qualities of the soft red winter wheats," was released in 1914. The same year two barleys, Michigan Winter and Derr Winter, were distributed. The notable disease resistant Robust Bean was first sent out from the station in 1913. A higher yielding selection from the same strain began supplanting the old line in 1918. The Improved Robust, another reselection, was admitted to the seed trade in 1921. Probably the best known of all the oat releases is the Wolverine, which made its first appearance in a farmer's field in 1917. Two well known spring barleys, products of Professor Spragg's breeding plats, are the Michigan Black Barbless and the Michigan Two-Row. In the field of alfalfa, the only strain so far released from the station is Hardigan, an acclimated strain high in seed and hay production. This release was made in 1920. Berkeley Rock, a hardy red winter type of wheat, was sent out in 1921. Bald Rock wheat, the last release to date, was sent out on approval in 1923.

These, in brief, are the chief productions from the breeding plats of Professor Frank A. Spragg. The increased benefits which these productions have brought to Michigan farmers cannot be estimated in dollars and cents. His interest in the welfare of the farmer did not stop with his producing a strain better suited to Michigan conditions and the delivering of that strain to the grower. He went further. He demanded that the farmer live up to his possibilities and keep the high-producing seed pure. It was his untiring backing of the Michigan Experiment Association and later the Michigan Crop Improvement Association that helped make pedigreed seed, grown by farmers, not only a possibility, but a reality.

His interest in his work, in civic affairs, and in scientific progress did not cause him to neglect his children. He was one of them in their games and in their interests. It was this concern for his family, his aggressive attitude in civic questions, his keen ability as a plant breeder, and his unfaltering belief in God, which endeared Professor Spragg to the hearts of those who worked with him in the field or laboratory or who associated with him after hours.

Cut showing Prof. Frank A. Spragg in Wheat Centgener Plots.

FINISHING BABY BEEF

Results of Experiments in Feeding Calves at M. S. C. During the Winter of 1924-25

G. A. BROWN AND G. A. BRANAMAN, ANIMAL HUSBANDRY SECTION

Requests for data on the most profitable ration to feed baby b[illegible] calves led the Michigan Agricultural Experiment Station to begin a series of experiments in the fall of 1923 to determine some of the factors to be considered in choosing a ration for these calves. Thirty head of choice steer calves were fed in three lots of ten each. The results of this experiment may be found in the Quarterly Bulletin for August, 1924.

In the fall of 1924, thirty head of heifer calves of quality similar to that of the steers, were fed in like manner and for an equal length of time. These calves were western or southwestern bred white-faced calves of choice quality, coming from the Kansas City Market. They arrived at the College October 28 and were fed alfalfa hay and corn silage until November 7, when the experimental feeding was started.

They were bought on the market for $6.40 per hundred weight, which, together with shipping expenses and feed for ten days, made the cost in the lots when the experiment started $7.30 per hundredweight.

Objects of Experiments

(1) Comparison of self-feeding of grain versus hand feeding with lighter grain ration, plus linseed meal added in each case with corn silage and alfalfa hay supplied according to appetite.

(2) Linseed oilmeal versus alfalfa hay as the source of protein in the hand fed ration.

Rations Fed

The basal ration of silage and alfalfa was continued in all lots throughout the experiment. The calves in each lot received all the silage they would clean up readily, twice per day, and alfalfa hay was kept before them in racks.

A mixture of equal parts by weights of shelled corn and whole oats was fed all lots the first 60 days, three parts corn and one part oats the next 30 days, and corn alone the last 100 days. The calves in Lots 1 and 2 each received, in addition, one pound of oilmeal per day the first 90 days, one and one-half pounds per day the next 60 days, and two pounds per day the last 40 days, fed on the silage night and morning.

Lot 1 was put on a self-feeder of grain at the end of 30 days, when by gradual increase they had reached a full feed. Lot 2 was hand fed twice daily approximately two-thirds the amount of grain consumed by Lot 1 throughout the experiment, beginning with approximately a half feed and gradually increasing until nearly a full feed was fed during the last 60 days. Lot 3 received no oilmeal, but was fed an amount of grain equal to the total weight of the grain and oilmeal fed in Lot 2, and it was fed in a similar manner.

Water in tubs was kept before the calves at all times, and a mixture of salt, bone flour, and sulphur was supplied. The calves were housed in a shed with doors opening to the east into small, cinder-paved lots. These doors were open except on the very coldest nights.

Gain by Pigs is Small

There were two pigs in each lot. These pigs were fed shelled corn and tankage at night, as much as they cleaned up readily. One pig in each lot would hardly have handled the feed available, judging from the amount of extra feed supplied.

Summary of Results

10 heifer calves per lot—(190 days—Nov. 7, 1924-May 16, 1925).

	Lot 1	Lot 2	Lot 3
Initial cost in lots	$7.30	$7.30	$7.30
Initial weight per calf	368.9 lbs.	369.3 lbs.	370.0 lbs.
Final weight per calf	772.9 lbs.	757.2 lbs.	731.2 lbs.
Total gain per calf	404.0 lbs.	387.9 lbs.	361.2 lbs.
Average daily gain	2.13 lbs.	2.04 lbs.	1.90 lbs.
Total feed consumed per calf:			
Corn	1667.3 lbs.	1118.4 lbs.	1251.3 lbs.
Oats	338.8 lbs.	200.4 lbs.	233.3 lbs.
Oilmeal	244.7 lbs.	244.7 lbs.	
Silage	1545.0 lbs.	3846.0 lbs.	2126.5 lbs.
Alfalfa	450.0 lbs.	538.0 lbs.	866.5 lbs.
Average daily ration:			
Corn	8.78 lbs.	5.89 lbs.	6.59 lbs.
Oats (fed 90 days)	1.78 lbs.	1.05 lbs.	1.23 lbs.
Oilmeal	1.29 lbs.	1.29 lbs.	
Silage	8.13 lbs.	20.24 lbs.	11.19 lbs.
Alfalfa	2.37 lbs.	2.83 lbs.	4.56 lbs.
Feed per cwt. gain:			
Corn	412.70 lbs.	288.32 lbs.	346.43 lbs.
Oats	83.86 lbs.	51.66 lbs.	64.59 lbs.
Oilmeal	60.57 lbs.	63.08 lbs.	
Silage	382.42 lbs.	991.49 lbs.	588.73 lbs.
Alfalfa	111.39 lbs.	138.69 lbs.	239.89 lbs.
*Feed cost per cwt. gain	$14.04	$12.44	$11.84
Feed cost per cwt. gain (deducting pork)	13.23	11.77	11.17
Necessary selling price (deducting pork)	10.40	9.59	9.21
**Selling price in lots	10.15	10.15	9.65
Initial cost of calves	269.30	269.59	270.10
Cost of feed	567.34	482.43	427.51
Total cost	836.64	752.02	697.61
*Value of pork (less feed eaten)	32.78	25.94	24.02
Total cost (crediting pork)	803.86	726.08	673.59
Final value in lots	784.49	768.56	705.61
Profit per calf (not considering pork)	—5.21	+1.65	+.80
Profit per calf (pork included)	—1.94	+4.25	+3.20
Price returned per bu. corn fed (including pork)	1.20	1.47	1.40

*Prices of feeds and pork: Corn, $1.26 per bu.; oats, 56 cents per bu; oilmeal, $55.00 per ton; silage, $5.00 per ton; alfalfa, $12.00 per ton; pork, $12.00 per cwt.

**Eighty-five cents was deducted from the Detroit price to give the actual value in the lots.

Feed Consumption Varied

A study of the table shows that Lot 1 consumed a relatively larger amount of grain, as compared with the other two lots, and consequently smaller amounts of silage and alfalfa. Lot 2 consumed considerably more silage and considerably less alfalfa than did Lot 3. The silage

consumed in Lot 3 is closer to the amount used in the self-fed lot than to that in Lot 2, the increased amount of alfalfa hay no doubt taking the place of a quantity of silage. The total of concentrates eaten by Lot 3 does not equal that in Lot 2, due to the fact that the calves in Lot 3 refused to take all the grain feed offered during the last 50 days. The silage was of poor quality, due to immaturity and to the small amount of corn contained. A comparison of total dry matter in the average daily ration shows Lot 1 to have received 14.75 pounds total dry matter per day per calf, Lot 2, 14.28 pounds dry matter, and Lot 3, 13.36 pounds dry matter.

Gains Correspond to Feed

A glance at the average daily gains shows the same general relationship between the gains in the different lots as was shown in the feed consumed. Lot 1 gained on the average 2.13 pounds, Lot 2, 2.04 pounds, and Lot 3, 1.90 pounds per day.

The pork produced is practically in proportion to the grain fed, and so the difference in cost of gains between the lots is not materially influenced by the pork produced. The cost of gains, deducting pork, show the gains in Lot 2 to be $1.46 per cwt. cheaper than those in Lot 1, and those in Lot 3 $2.06 per cwt. cheaper than those in Lot 1.

The necessary selling price in the lots to break even, pork considered, is $10.40 per cwt. in Lot 1, $9.59 in Lot 2, and $9.21 in Lot 3, a difference of 81 cents between Lots 1 and 2, and only 38 cents between Lots 2 and 3. In other words, in order to pay market price for the feed as charged in the table, Lot 2 must sell for 38 cents more per cwt. than Lot 3, and Lot 1 must sell for $1.19 more than Lot 3.

Livestock commission men from Detroit valued the calves as they stood in the lots at the close of the experiment as follows: Lot 1—$11.00, Lot 2—$11.00, Lot 3—$10.50, Detroit prices. Previous results show that about 85 cents per cwt. will cover the marketing expense and the shrinkage, making the net price in the lots $10.15 per cwt. for Lots 1 and 2, and $9.65 for Lot 3.

If the initial cost of the calves in the lots had been one dollar per hundred higher, the margin would have been reduced so that a net loss would have been shown in Lot 3 and a profit of only 55 cents per calf in Lot 2. If Lot 2 had sold for 56 cents per cwt. less, and Lot 3 for 44 cents per cwt. less, no profit would be shown in either lot. This shows the necessity for very conservative buying.

Returns Per Bushel of Corn

When the other feeds have been charged at the prices shown in the table, and the returns above that are credited to the corn fed, a price of $1.20, $1.47, and $1.40 per bushel is shown for the corn fed the calves in the respective lots.

THE IMPORTANCE OF WELL CURED HAY IN THE RATION OF DAIRY CATTLE

Crude Fibre and Sunshine Fail to Provide Necessary Factors in Experiments at Michigan Station

O. E. REED AND C. F. HUFFMAN, DAIRY SECTION

Feeders of live stock have always looked forward to spring when their cattle could be turned on pasture for it has long been recognized that luxuriant pasture has a wonderfully beneficial effect on the physical condition of animals and stimulates greater milk production in the case of dairy cattle. Unfortunately, the period of abundant pasture is a very brief one in most sections. This necessitates the feeding of dry feed and silage most of the year, and cattle feeders have often attempted to imitate the almost ideal pasture conditions of late spring and early summer. Feeds, such as silage, beet pulp, and root crops add succulence to the ration, a factor furnished by pasture in pasture season.

Hart and his co-workers at the University of Wisconsin have demonstrated that the vitamin which aids in mineral retention, found so abundantly in green foods, can be preserved to a considerable extent by the method of curing hay. They found that hay cured in cocks and under caps contained more of the mineral retention vitamin than hay cured in the swath.

Several investigators have shown that calves cannot be grown from birth to maturity on a ration free from roughage. Since the digestive system of the ox is especially constructed to handle bulky, coarse feed, the assumption has been made that a certain amount of coarse food or crude fiber is necessary for proper physiological functioning. McCandlish, of the Iowa Experiment Station, was able to prevent physiological failure in calves fed concentrates by supplementing the concentrate ration with alfalfa hay.

However, the coarse food or crude fiber furnished by the hay is not the vital factor, as the work of the Dairy Department at the Michigan Station shows. A grain ration complete in energy, protein, minerals, and vitamins, and sunshine, supplemented with wheat straw, failed to keep a heifer from dying. Three calves receiving a ration of whole milk and straw failed to develop normally and died. Another calf died on a ration of skim milk, corn, and oats, and all the oat hulls he would eat. Additional crude fiber furnished by wheat straw and oat hulls failed to meet the deficiency of a concentrate ration when fed to young ruminants.

Apparently crude fiber is not the vital factor carried by green pasture and well cured hay.

Factors Carried by Green Pasture and Well Cured Hay Are Necessary in the Ration of Dairy Cattle for Proper Health of Reproduction

In order to determine the value of crude fiber in the ration of dairy cattle, four grade Holstein heifers about one year of age were placed on the following basal grain ration:

400 pounds yellow corn
50 pounds corn gluten (Diamond)
50 pounds cottonseed meal
5 pounds salt

Heifers numbers 205 and 207 were fed the basal grain ration, and five per cent wheat straw in addition. The other two heifers, numbers 200 and 201, received all the wheat straw they could eat, in addition to the basal ration.

Heifer number 207 died in a convulsion after being on this ration 270 days.

Heifers number 205 and number 201 calved prematurely. Number 205 gave birth after seven months of gestation to a weak, paralyzed calf that lived only two days. Number 201 gave birth to a dead calf after eight months gestation. Both heifers had retained afterbirths. Their reproductive failure was not due to contagious abortion, but to a lack of the factor or factors carried by cured hay or pasture. These two heifers not only failed to reproduce properly, but they also failed to show udder development.

Heifer number 200 received all the straw she would consume, in addition to the grain ration. After a year on this ration she became very stiff in the joints, the legs were swollen, the coat dull, the hide was tight and thick, and the eyes dull. Cod liver oil was added to the ration at the rate of one-fourth pound per day for four days, and one-fourth pound per week thereafter. As soon as the cod liver oil was fed, a remarkable change took place in the health and appearance of this heifer. The swelling and stiffness disappeared, the eyes became bright, the coat of hair became slick, and she carried her calf full time. Although the calf was carried the full period, it was born blind and paralyzed, and lived only 18 days. This heifer also had a retained afterbirth.

The additional straw consumed by numbers 200 and 201 failed to produce any beneficial effects so far as reproduction was concerned. Both animals developed stiffness in the legs and failed to shed their coat while on the ration of grain and wheat straw. The addition of cod liver oil corrected the deficiency of such a ration so far as the health of the cow was concerned, but the feeding of grass or well cured hay, instead of straw, would have resulted in successful reproduction.

In this experiment sunlight had very little beneficial effect. All the heifers received seven hours of sunlight daily except on cloudy days. Evidence of malnutrition did not appear until in May, when there is considerable ultra-violet ray in the sunshine. Heifer number 201 aborted May 11th, and heifer number 205 aborted August 25th, while number 200 did not develop stiffness until in May. It is likely that

dairy cattle are unable to ultilize the beneficial effect of the sun's rays unless green food or well cured hay is fed.

Properly cured hay and green food carry factors that are not only beneficial to the proper development of calves but are also necessary for proper reproduction.

Hay should be cured with as little exposure to sunlight as possible, since sunlight destroys its vital properties. The feeding of good quality hay will do more to keep up the health of the dairy herd than any other single factor. The feeding of mineral supplements furnishing lime is of little value unless the mineral retention factor is supplied in pasture or well cured hay.

Well Cured Hay or Green Food is Necessary in the Ration of Dairy Cattle to Cause the Annual Shedding of Hair

The idea that cattle shed their winter hair in the spring is universal. Shedding hair by cattle is thought to be due to the season of the year. The beneficial effects on the health of the animal body due to the ultra-violet ray of the sun's light may account for the seasonal shedding of hair. The sunshine in the spring and summer is much richer in this beneficial ray than is the winter sun, and besides the animals are usually under cover in the winter, which means that very little of this factor is obtained by the animal body during that season.

The Michigan State College Dairy Department, in co-operation with the Michigan Experiment Station Chemistry Department, is experimenting on the value of cured hay and green food in the ration of dairy cattle. Cattle fed concentrate rations free from green food or hay, even though energy, protein, vitamins and minerals were present in adequate amounts, failed to shed their winter coat of hair in the spring and summer. When alfalfa hay was fed, even in a dry lot, the cattle shed their long winter coats.

Heifer number 205, on a ration of yellow corn, corn gluten, cotton-seed meal, salt, and five per cent wheat straw, failed to shed during the spring and summer, even though she was turned into an open lot from 8:00 A. M. to 3:00 P. M. daily for exercise and sunshine.

Heifer number 200, receiving the same grain ration as heifer number 205 and all the wheat straw she cared for, failed to shed until the middle of June, at which time cod liver oil had been added to the ration. A complete loss of the winter coat of hair took place after the addition of cod liver oil to the ration.

Four animals were fed a good concentrate ration free from hay or green food. The condition of these animals on July 11, 1925, as shown in the following table.

No. of Animal	Age	Ration	Condition of Coat
C 16	21 mo.	Whole milk, sirup of iron phosphate.	Hair long, has never shed.
C 22	19 mo.	Whole milk, wheat bran.	Hair long, has never shed.
C 25	15 mo.	Whole milk, wheat bran, sirup of iron phosphate.	Hair long, has never shed.
C 27	14 mo.	Whole milk, sirup of iron phosphate.	Hair long, has never shed.

These animals were turned out in a dry lot from 8:00 A. M. to 3:00 P. M. daily, which gave them ample sunshine. It is evident that sunshine alone cannot bring about shedding of hair in dairy cattle. The ration must contain cured hay or green food before the sunshine can assist the animal in shedding its long winter coat. A good ration, one containing plenty of well cured hay or one supplemented with abundant pasture, is the basis of proper nutrition of dairy cattle. Sunshine, although it has a beneficial effect on the animal body, is secondary to a good ration. Sunshine is more effective in live stock feeding if the ration contains green food or well cured hay.

Five heifers on our long time mineral feeding experiment, receiving a basal ration of grain, silage, and timothy hay, supplemented with a complex mineral mixture, failed to shed during the spring and summer. The check lot on the basal ration low in minerals have all lost their winter coat, which gives them a much healthier appearance. This complex mineral mixture contains calcium carbonate, bone flour, salt, and a little of each of the following minerals: bone charcoal, copperas, Epsom salts, Glauber's salts, potassium chloride, and potassium iodide.

This is a "shot gun" mineral mixture—the idea being that if one mineral did not do the work another would. This mineral mixture, when fed at the rate of two ounces daily, had a detrimental effect on the health of the animal and also prevented the shedding of the winter coat of hair.

Fig. 1.—Cow 200, before receiving cod liver oil. The ration consisted of grain and wheat straw. Notice the run-down physical condition.

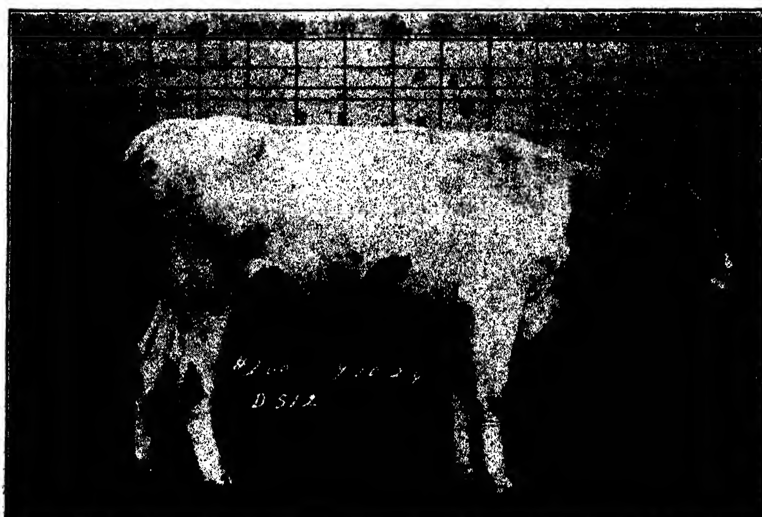


Fig. 2.—Cow 200, after receiving cod liver oil in addition to a ration of grain and wheat straw for three months. Notice the changed appearance.

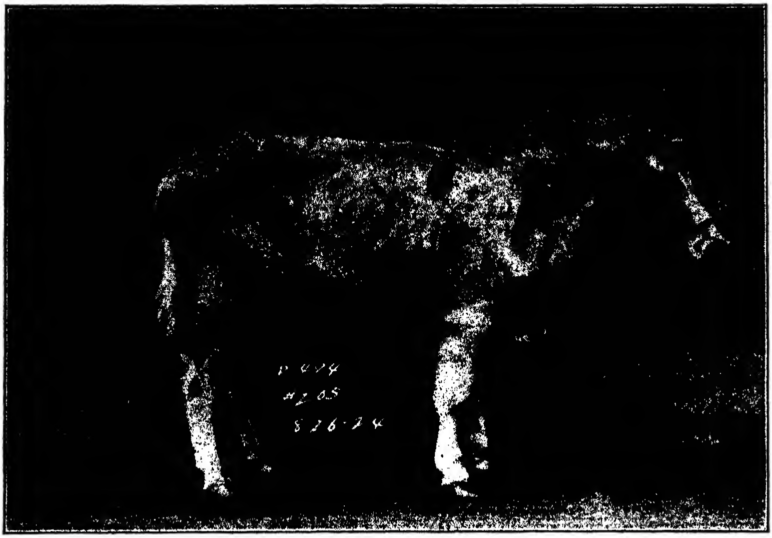


Fig. 3.—Note the long, shaggy coat of hair on this animal. She received a ration of yellow corn, corn gluten, cottonseed meal, salt, and wheat straw. This ration lacked well-cured hay or green food necessary for the proper nutrition of dairy cattle.

Fig. 4.—Heifer C-25 failed to shed the long coat of hair on account of the lack of a factor carried by cured hay and green food.

WHEN TO PICK APPLES

To What extent Do Factors Associated With the Ripening of Apples Indicate the Stage of Maturity?

ROY E. MARSHALL AND GEO. F. WALDO, HORTICULTURAL SECTION

Casual observation in any commercial apple section shows that there is a decided lack of uniformity in maturity standards among fruit growers. One grower may pick a variety when the fruits attain approximately a certain specified size; a neighbor may base his time of picking on color development; another waits until the apples begin dropping; still others pick varieties in a certain succession with more or less disregard of the stage of maturity of the fruits. Consequently, one may go to almost any large market or into any community packing house and find great diversity in maturity and quality of product in fruits of a single variety and grade, as graded and packed according to usually accepted standards. Yet it stands to reason that greater uniformity in this respect would tend to stabilize and standardize prices and would be of value to consumer, dealer and producer. Unfortunately, no one has been able to formulate a rule or set of rules that would apply equally well in determining the time of picking all varieties, or even a single variety grown under diverse environmental and climatic conditions.

The office of Horticultural and Pomological Investigations of the United States Department of Agriculture, in co-operation with several state experiment stations, including the Michigan Experiment Station, has been studying certain aspects of this problem for several years. This report is based on the results of two seasons work in the college orchard at East Lansing. The varieties involved were Ben Davis, Delicious, Winesap, Jonathan and Baldwin. The trees from which the fruits were taken were in full bearing and had been growing in sod since 1921. Briefly the method of procedure was to make series of observations and measurements on a number of representative specimens at approximately ten-day intervals, beginning August 24 in 1923 and August 22 in 1924, and correlate these records with picking season, grade, dessert quality of fruit and keeping quality.

Apples Continue to Increase in Size Until Picked

Tables 1 and 2 present figures showing the amount of increase in size of apples at ten-day intervals for a period of about eight weeks just before harvest, for the season of 1923 and 1924. One hundred specimens of each variety were measured. The important point brought out by these figures is that both seasons the fruits of all varieties con-

tinued to increase steadily in size until the time of picking. This is in line with similar records that have been obtained in other sections and lead unmistakably to the conclusion that from the standpoint of bulk or quantity and likewise from the standpoint of grade, to the extent grade is influenced by size, the longer apples may be allowed to hang on the trees the better. The storage tests made incident to this study and likewise general observation indicate that neither dessert quality nor keeping quality is impaired by delaying harvesting so as to obtain the benefit of much of this late increase in size.

Comparison of the figures in the two tables incidentally brings out the fact that size varies considerably from season to season and emphasizes the point that little reliance can be placed on this factor alone as a measure of maturity. It is interesting to note that a heavy rainfall (6.18 inches from August 24 to October 15) characterized the preripening period in 1923 and a light rainfall (3.05 from August 22 to October 24) characterized the corresponding period in 1924 and that size of fruit was materially influenced by this difference. The fact that the April-November precipitation for the two years was practically the same (20.94 inches in 1923 and 19.17 inches in 1924) serves to emphasize still more the importance of rainfall late in the growing season in determining the size of apples.

Picking Season as Influenced by Color

Tables 3 and 4 present data on the development of the red color of apples, corresponding to those presented in Tables 1 and 2 on size. It is evident from these figures that this does not take place with the same degree of uniformity as increase in size. As a matter of fact, color development is very irregular, the fruit coloring rapidly one week and perhaps hardly at all the week following. Apparently, this is influenced greatly by weather conditions, though from the data available it is impossible to assign to the different factors of environment, such as sunshine, temperature and humidity, their places of relative importance. In a general way, it may be stated that from the standpoint of color, as well as from the standpoint of size, much will be gained by delaying picking as long as is practicable.

The color of the unblushed surface has been considered a fairly reliable indication of maturity. In general, the unblushed surface of an apple changes from green to a yellowish green and sometimes the green entirely disappears as the apple ripens. The rate of this change is somewhat variable, but it is much more constant than the rate of increase in red color and not readily influenced by weather conditions. Removal from the tree does not stop this ground or under-color change, as is the case with the red color, but it continues to take place in apples in storage—the rate being determined by the variety, temperature, and humidity of the storage. In some varieties the color of the unblushed surface is a good indication of the time to pick, but this indicator cannot be made to apply generally with all varieties.

Softening of Flesh as a Measure of Maturity

It is well known that the flesh of a fruit becomes softer as it ripens. Some growers judge the maturity of apples, especially summer apples,

by pressing the thumb against the flesh. The Oregon Experiment Station found this principle to be one of the best methods to employ in determining when to pick pears for eastern shipments, but instead of using the thumb they devised a mechanical pressure tester whereby one can measure the pressure in pounds required to press a ball five-eighths inch in diameter into the surface of the flesh of the fruit. Several investigators have used these pressure testers to determine the rate of softening of various fruits while growing on the trees or while being held in storage. The tester used in these investigations is similar to the one described in Oregon Station Bulletin No. 186. Tests were made with this instrument at 10-day intervals during the ripening seasons of 1923 and 1924. Each variety was tested for firmness with the skin intact and again with the skin removed. These tests showed that with a single variety and during a single season the rate of softening is fairly steady up to the time of commercial picking. However, softening of the flesh takes place slowly during this period and in this test was found to vary considerably from season to season. Consequently, the value to the growers of a device of this kind may be questioned.

Change of Seed Color

Change in color of seeds cannot be taken as an indication of maturity because in most varieties studied the seeds changed color early in the season. Delicious, Jonathan, and Winesap changed quickly to a brown color long before the fruit was ready to be picked. The rate and time of change in seed color is fairly constant. Seasonal changes do not seem to cause any great variation in the rate of change.

Dropping: Ease in Picking

Ease of separation of fruit from the spur is probably the most widely used indicator of the time to pick apples for commercial use. Most varieties in commercial use are picked when the apple easily separates from the spur with the stem intact, if a slight twist is given the apple as it is pulled off. However, some varieties like Wealthy and McIntosh will naturally begin to drop before picking time and continue dropping during the harvest season. This often means that two or more pickings may be found advantageous.

Recommendations

It is evident that no one of the factors considered in this investigation may be entirely relied upon as a basis for picking or maturity standards. Such factors as ease of separation of fruit from spur and change of color on the unblushed surface are the more reliable indicators of maturity. The determination of the time of picking, then, must continue to be based upon the judgment of the grower, who may be guided by such factors as tendency of the variety to drop or ease of separation from the fruit spur, change or under color from green or yellowish green to greenish yellow or yellow. Labor supply, duration of the picking season before danger from severe freezing, market demands and many other factors must also be given due consideration.

The measurements of size have clearly shown that apples continue to increase in size as long as they remain alive on the trees and that apples continue to increase in color as long as they remain on the trees provided full color for the variety has not been attained. An increase of one-eighth inch in the size of each apple means an increase of eight to ten per cent in yield. Furthermore, many of the B grade apples are of this grade because of deficiency of size or color. Again, highly colored and well matured apples usually possess the best keeping qualities.

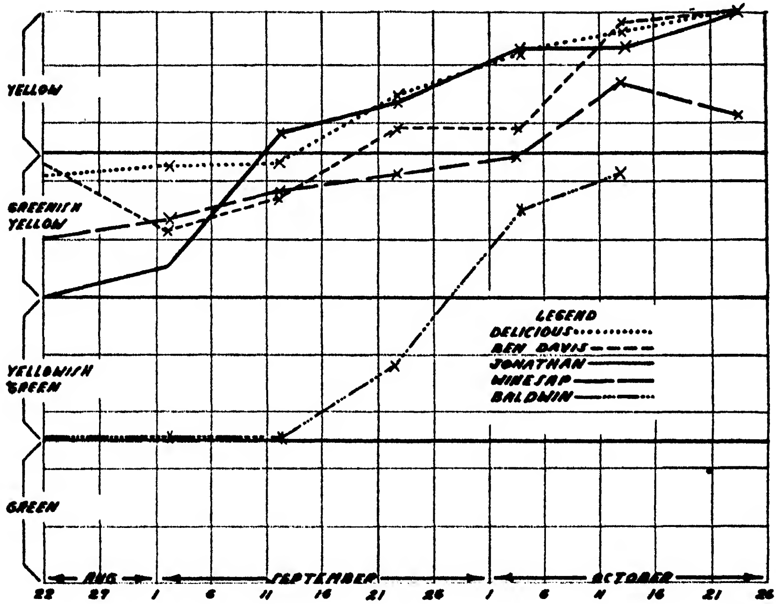


Fig. 1.—This chart shows the rate and degree of change of color on the unblushed surface of five varieties of apples during the seasons of 1923 and 1924 (Baldwin 1923 only). It is evident that the change of color on the unblushed surface may serve as a guide as to time to pick such varieties as Baldwin and Jonathan, but with the other three varieties the color change is too gradual to serve as a guide.

TABLE 1.—AVERAGE CIRCUMFERENCES OF APPLES, 1923 (centimeters)

Variety	Aug. 24	Sept. 5.	Sept. 17	Sept. 25	Oct. 5	Oct. 15
Delicious	18.2	19.6	20.7	21.3	22.8	....
Jonathan	15.1	15.9	16.5	17	16.5	....
Ben Davis	17.1	18.3	19.5	20.5	21.2	22.0
Winesap	16.7	17.7	18.5	19.2	19.9	20.1
Baldwin	15.6	16.4	17.4	18.1	18.9	19.1

TABLE 2.—AVERAGE CIRCUMFERENCES OF APPLES, 1924 (centimeters).

Variety	Aug. 24	Sept. 5	Sept. 17	Sept. 25	Oct. 5	Oct. 15
Delicious	17.5	18.4	18.9	20.0	20.6	20.9
Jonathan	14.8	15.6	16.3	17.0	17.6	18.2
Ben Davis	16.4	16.9	17.5	18.0	18.9	20.0
Winesap	13.9	14.7	15.2	15.8	16.1	16.9

TABLE 3.—PERCENTAGE OF RED COLOR, 1923.

Variety	Aug. 24	Sept. 5	Sept. 17	Sept. 25	Oct. 5	Oct. 15
Delicious	42	51	62	74	78	....
Jonathan	57	75	80	82	96	....
Ben Davis	40	43	54	59	56	87
Winesap	35	23	32	58	73	93
Baldwin	22	20	26	25	53	73

TABLE 4.—PERCENTAGE OF RED COLOR, 1924

Variety	Aug. 22	Sept. 2	Sept. 12	Sept. 23	Oct. 4	Oct. 13	Oct. 24
Delicious	6	15	45	51	65	81	76
Jonathan	8	10	64	65	85	82	90
Ben Davis	5	5	40	48	57	59	59
Winesap	5	7	41	44	59	65	66

WHY VENTILATE FARM BARNS AND HOW

A Discussion of Fundamental Rules to Consider in Ventilating Systems

F. E. FOGLE, AGRICULTURAL ENGINEERING SECTION

The operation of a bellows to feed air to the blacksmith's forge blast is a splendid illustration of the necessity of fresh air. As the blacksmith operates the lever, the bellows rises and falls to feed air to the bed of coals at the rate of at least three pounds of air for each pound of coal burned. As the blacksmith draws the red hot iron from the forge and hammers it into shape, you will note the rise and fall of his chest. Here we have another bellows feeding air into another forge, to produce the energy for health and vigor. This human bellows must supply about a cubic foot of air every three minutes to enable the blacksmith to do his best work and maintain health.

The farmer, if he be a good judge of a cow, selects one with constitution. He wants a cow with a deep chest, width between the fore-

legs, a well sprung front rib, and large, prominent nostrils. He knows that such a cow has a bellows or lung capacity to supply the energy to enable her to convert large quantities of raw materials, such as grass, hay, and grain, into the finished products—milk, and butter fat or beef, as the case may be. Yet she is no more valuable than a cow showing less evidence of constitution unless she is afforded an abundant supply of fresh air. It is absolutely impossible for her to do her best work, and be most profitable, in a damp, dark, or poorly ventilated barn. Furthermore, in such a barn she will more easily contract tuberculosis, contagious abortion, and other diseases.

Has it ever occurred to you that the necessary elements for life are furnished in proportions relative to their importance? We are living at the bottom of a vast sea of air many miles deep; water is comparatively abundant, but we must put forth effort for food. Life may be sustained scarcely five minutes without air, five days without water, and possibly five weeks without food. It is a mistake not to secure for ourselves, and for our farm products and animals, the necessary quantities of fresh air.

Ventilation may be defined as the changing of the air in any room or space. It is a means of supplying fresh air, controlling temperature, controlling humidity, or moisture, and removing foul air and objectional products which cause odors. Ventilation is necessary for the health and comfort of animals. It will preserve the building and contents from mold and rot, due to excessive moisture, and will aid in the prevention and control of disease.

There was a time, before the advent of tight buildings, when poultry houses, barns, and other farm buildings did not need ventilation. There are barns today where the construction is such that there is ample movement of air through leaky walls, hay chutes, silo chutes, and stairways. Such buildings in extreme weather, however, become too cold for fowls or animals to give economical production.

With the advent of tight buildings, comes the necessity for ventilation. For best results we must admit fresh air, remove stale air, and control temperature and humidity.

In considering ventilation for farm barns, it should be understood, as a general rule, that air cannot be drawn into the building unless some is removed; neither can air be taken out of a building unless some is admitted.

A system for ventilation consists of openings or inlets to admit air, openings or out-takes to remove air, and some means of creating a movement of air.

Movement of air through a building may be secured by two methods, natural and artificial. Artificial ventilation, or the use of a fan for driving air through a building, is practically never used on the farm. Natural movement of air through a building is caused by wind force, by wind suction over the top of a ventilating flue, by differences of temperature between inside and outside air, or by all three forces acting together. The factor having the greatest effect on natural ventilation is the heat which is supplied by the animals in a building. The heat in a stove causes a "draft," or, in other words, creates a movement of air. Everyone has watched a bon-fire and has probably noticed that the heat was setting up an air movement. As air was warmed by the fire,

it became lighter and was forced upward by the colder, heavier air which rushed in at the base of the fire. Just so, air movement is set up by the heat from animals in a building.

Since the heat to create an air movement through a barn must be furnished by the animals in the barn, it is evident that the kind and size of animals and the construction of the barn must be carefully considered. A cow or horse weighing 1,000 to 1,200 pounds will heat approximately 600 cubic feet of space in a well built barn. In a climate

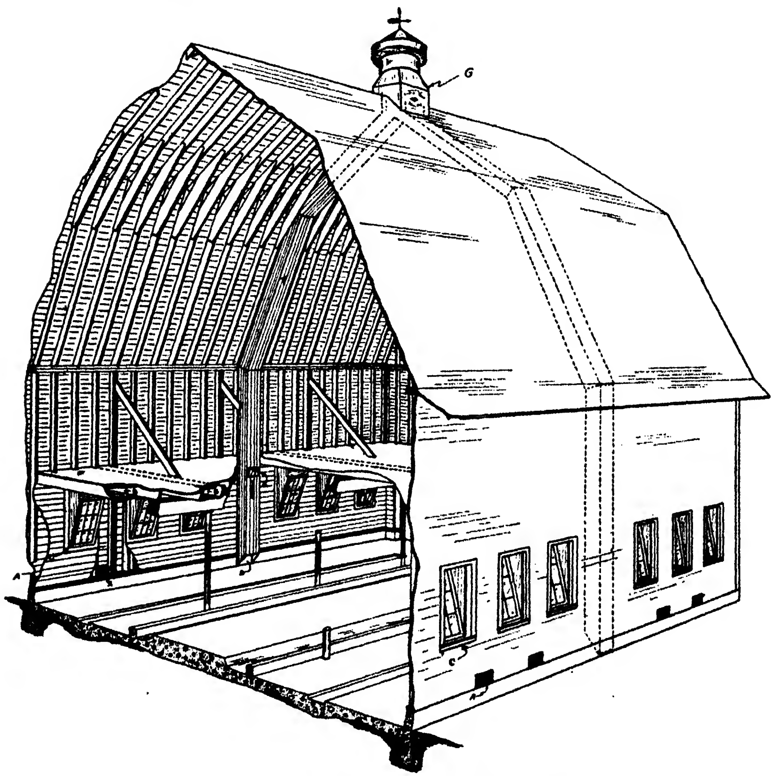


Fig. 1.—Showing the method of installation of the King System of ventilation. At "A" is a wall flue intake. At "C" is a window intake. "F" is the out-take flue. The bottom of the out-take flue should be left open, as shown at "D." "E" is a heat door in the out-take flue.

as cold as Michigan's the cubical content of the stable is very important. Only such space as an animal can heat should be provided. For dairy barns, the ceiling height should not be over 8 feet in the clear, and for horse stables, eight and one-half feet to nine feet should be the maximum.

Many difficulties in ventilation are due to poor wall construction. In a stable having a thin wall, the heat loss may be too great, and as

a result air movement will be stifled. Furthermore, condensation will take place causing moisture or frost to collect on the fall.

There are three types of ventilating systems which differ from each other principally in the relation of the intakes to the out-takes. The King system was devised some 30 years ago, by the late Professor F. H. King, of the University of Wisconsin. The King system admits the air near the ceiling and removes it from near the floor.

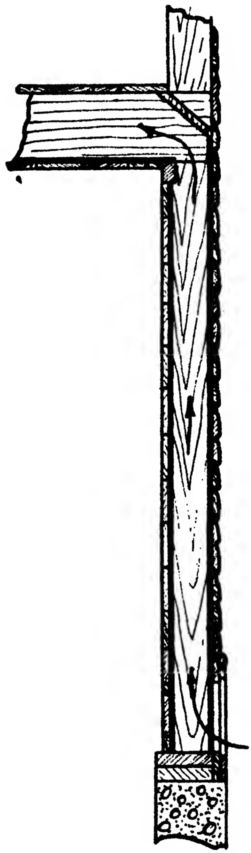


Fig. 2.—The intake flue is open on the outside on the bottom and at the inside at the top.

A system which admits the air at the floor and removes it from the ceiling was designed by Professor Rutherford, of Ontario.

A commercial concern is marketing a system which admits air at the ceiling and also draws it off at the ceiling.

The King system of taking foul air out of the barn near the floor and admitting fresh air near the ceiling has proved very satisfactory, and we are safe in saying that it is the most widely used.

In this system the air intakes should be small, not more than 6"x14", and there should be many of them. They should be placed every eight to twelve feet around the building. The opening on the inside should be near the ceiling, while on the outside it should be about four feet lower. This difference in height of openings prevents the intake from acting as an out-take, and also prevents too great an intake of air during strong winds.

Wherever studding is used in construction, the intakes may be simply the space between studding. In case of masonry walls, the intake flue may be brought through the wall low, and pass upward to the ceiling, or it may rise on the outside of the wall and enter at the ceiling. There are, on the market, patented aluminum intakes which may be placed in the wall at the ceiling line. This type has a nicely balanced shutter

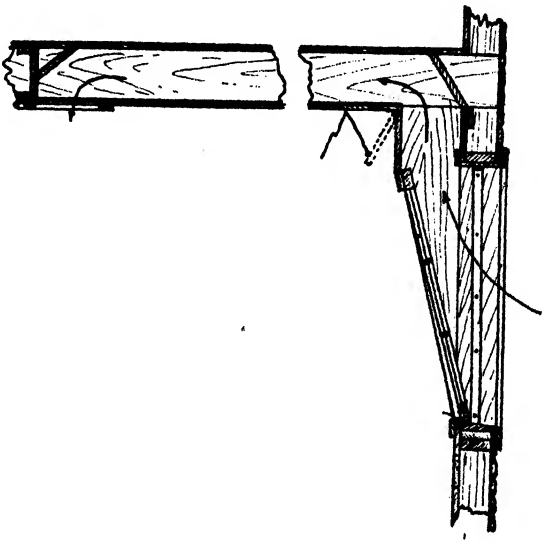


Fig. 3.—Windows may drop in at the top and be equipped with cheek boards to serve as intakes.

which permits air to enter it and will close to prevent air from going out.

A window equipped to operate as shown in Fig. — may be used as an intake, although it is not as satisfactory as a permanent, insulated flue, and furthermore it will need more careful management.

In Fig. 1, it will be noted that the cattle face in and that the intakes are carried between the joist to empty near the center of the barn, with the out-takes near the outside. In case the cattle face out, the intakes should empty near the outside wall, with the out-take flues near the center and with space between them to permit a carrier load of hay to pass.

The out-take flues should be as few and as large as practicable. They should be as straight as posible, extend as high as the highest

point of the roof, and be fitted at the top with a properly designed roof ventilator.

The large, straight flue permits the passage of air with less friction, and consequently will handle a larger quantity of air.

The high out-take flue is especially desirable because both the heat effect and the suctional effect of wind increase with the height. The suctional effect is greater because wind velocity increases with the distance above the surface of the earth. A properly designed roof ventilator at the top of the out-take flue will tend to create a suction on the flue, no matter in which direction air moves across it. This is true even though the wind blow directly down onto the ventilator. The home-made wooden cupola is very often a hindrance to the movement of air.

The out-take flue should have every feature which goes to make a

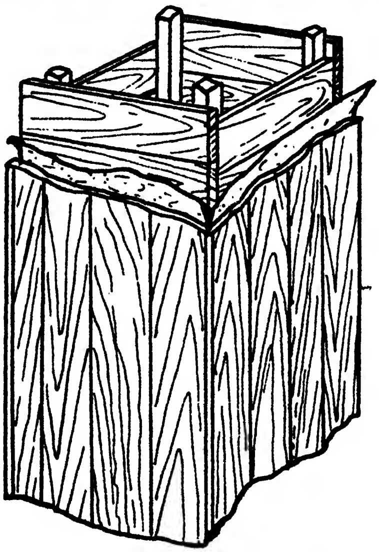


Fig. 4.—A section of an out-take flue.

good chimney, except, of course, that it need not be fireproof. The walls should be air-tight and they need insulation to make them non-conductors of heat. A round flue of galvanized iron carefully insulated is the most satisfactory type. A fairly satisfactory flue may be constructed of two thicknesses of matched lumber, with a layer of one or two-ply roll roofing between them. One layer of lumber should run crosswise of the flue and the other lengthwise to prevent swelling and shrinking of the wood, as much as possible.

The out-take flue should be fitted with a door at the ceiling line which can be controlled. This door may be opened for summer ventilation and when it is desired to get a rapid movement of air to lower the temperature of the stable.

All flues, both intake and out-take, should be fitted with dampers, so that they may be under control at all times.

The total capacity of the ventilating flues should be in proportion to the number, kind, and size of animals housed.

One square foot cross sectional area of out-take flue for each four cows or horses, is a rule commonly followed. Thus a flue two feet square, having a cross-sectional area of four square feet, would furnish ventilation for 16 cows or horses.

An arbitrary rule, such as this one is, should be applied with judgment. This rule would apply to cows or horses weighing 1,000 to 1,200 pounds. Animals weighing 1,800 or 2,000 pounds would require proportionately larger flues to accommodate them.

The total cross-sectional area of all the intakes should be equal to, or slightly greater than the total cross-sectional area of the out-take flues.

Air cannot be drawn to a flue from a distance greater than about 30 feet. There should be an out-take roof ventilator for approximately each 35 feet of length of a barn 36 to 40 feet wide.

It is a comparatively simple matter to lay down general rules for the installation of a ventilating system. However, there are so many factors which may affect the operation of a system, such as unusual barn shape, partitions, air leakage, etc., that experience is necessary to design a system with any degree of assurance that it will be satisfactory. There are home-made systems that work splendidly, and there are others that have required several attempts to be made satisfactory.

Definite rules for the King system of ventilation are:

1. The stable should be of tight, warm construction.
2. Allow 600 cubic feet of space for each 1,000 pound animal, or equivalent.
3. Intakes should be many and small.
4. Intakes should be located every 8 to 12 feet around the building.
5. Intakes enter at ceiling, open at outside about four feet lower.
6. Intakes should be insulated.
7. Out-takes few and large.
8. Out-takes draw from 15″ above floor.
9. Out-takes equipped with heat door near ceiling.
10. Out-takes insulated, straight, high, and fitted at the top with a roof ventilator.
11. Allow one square foot of out-take flue for four 1,000 to 1,200 pound cows or horses, or equivalent in other livestock.
12. Total capacity of intakes should be equal to or slightly greater than out-takes.
13. Air can be drawn to the out-take a maximum of about 30 feet.
14. One roof ventilator for each 35 feet in length of a barn 36 feet to 40 feet wide.

THE MICHIGAN LEGISLATURE ADOPTS STANDARD GRADES FOR POTATOES

J. W. WESTON, FARM CROPS SECTION

Growers and shippers of potatoes generally have come to appreciate the importance of placing a well graded product upon the market. Sufficient interest in this potato grading work has been created so that the people handling the bulk of the Michigan potato crop asked that the 1925 State Legislature put potato grading work on a firm and definite basis. Legislative action was taken, and Act No. 76 of the Public Acts of 1925 will regulate the sale of potatoes by fixing standard grades and will provide for inspection and penalty for violation of the law. This law goes into effect August 27, 1925, or ninety days after the official adjournment of the 1925 Legislature.

Michigan adopted the Federal Standard for potato grades in October, 1923, by order of the Commissioner of Agriculture. For two shipping seasons this work has been carried on successfully. Full credit should be given to the Division of Fruit and Vegetable Inspection of the State Department of Agriculture for the effective work they have done.

Investigations made in the winter of 1923 by representatives of the Michigan State College on several of the large potato consuming markets, such as Pittsburgh, Cleveland, Toledo, and Detroit, showed poor grading to be general in Michigan potatoes. Many lots were examined, and an average of twenty-two per cent of culls and inferior stock was found that never should have been shipped to market. This poorly graded stock injured the sales of the good Michigan stock, so that Michigan potatoes on the average brought thirty to forty cents less a 150-pound sack than did those from other states which had a reputation for good grading and for shipping uniformly good stock.

It is generally conceded that the eating and cooking quality of Michigan sand-land potatoes equals that of potatoes from any other section. Investigations made by the Michigan State College in the winter of 1925 in cities such as Pittsburgh, Cleveland, Columbus, and Detroit showed that Michigan potatoes at that time compared very favorably with potatoes from other sources, and were as well graded as to size, as free from mechanical injury, and of as good appearance. There was still a slight discount made on account of Michigan's former reputation, and the price per 150 pound bag was slightly less than that paid for potatoes from states that have always maintained a high standard of quality. With the stability this new law will give to the uniformity of the grade and quality of Michigan potatoes, this slight difference in price should disappear.

The adoption and promulgation of the potato grades has resulted in a considerable gain to the potato growers. It is estimated that the

1923 crop was increased one and three-quarters millions dollars in value and the 1924 crop two million dollars by the program for better grading.

The following standard grades for potatoes are quoted from Circular No. 118 of the State Department of Agriculture, Lansing, Michigan. They are found in Act No. 76, Public Acts of 1925.

Section 1. U. S. FANCY shall consist of potatoes of one variety which are mature, bright, well shaped, free from freezing injury, soft rot, dirt, or other foreign matter, sunburn, second growth, growth cracks, hollow-heart, cuts, scab, blight, dry rot, disease, insects or mechanical injury and other defects. The range in size shall be reasonably uniform, and in no case shall the diameter be less than two inches.

In order to allow for variations incident to proper grading and handling, not more than five per cent, by weight, of any lot may vary from the range and size stated, and, in addition, not more than three per cent, by weight, of any lot may be below the remaining requirements of this grade, but not to exceed one-third of this three per cent tolerance shall be allowed for potatoes affected by soft rot.

Section 2. U. S. NO. 1 shall consist of potatoes of similar varietal characteristics which are not badly misshapen, which are free from freezing injury and soft rot and from damage caused by dirt or other foreign matter, sunburn, second growth, growth cracks, hollow-heart, cuts, scab, blight, dry rot, disease, insects or mechanical or other means.

The diameter of potatoes of round varieties shall be not less than one and seven-eighths inches, and of potatoes of long varieties, one and three-fourths inches.

In order to allow for variations incident to proper grading and handling, not more than five per cent, by weight, of any lot may be below the prescribed size, and, in addition, not more than six per cent, by weight, may be below the remaining requirements of this grade, but not to exceed one-third of this six per cent tolerance shall be allowed for potatoes affected by soft rot.

Section 3. U. S. NO. 1 SMALL shall consist of potatoes ranging in size from one and one-half inches to one and seven-eighths inches in diameter, but meeting all the other requirements of U. S. No. 1.

In order to allow for variations incident to proper grading and handling, not more than twenty-five per cent, by weight, of any lot may vary from the prescribed size, but not to exceed one-fifth of this tolerance shall be allowed for potatoes under one and one-half inches in diameter. In addition, not more than six per cent, by weight, may be below the remaining requirements of this grade, but not to exceed one-third of this six per cent tolerance shall be allowed for potatoes affected by soft rot.

Section 4. U. S. No. 2 shall consist of potatoes of similar varietal characteristics which are free from freezing injury and soft rot and from serious damage caused by sunburn, cuts, scab, blight, dry rot, disease, insects or mechanical or other means.

The diameter of potatoes of this grade shall be not less than one and one-half inches.

In order to allow for variations incident to proper grading and handling, not more than five per cent, by weight, of any lot may be below the prescribed size, and, in addition, not more than six per cent, by weight, may be below the remaining requirements of this grade, but

not to exceed one-third of this six per cent tolerance shall be allowed for potatoes affected by soft rot. Any potatoes other than those mentioned in this act shall be sold as "culls" and marked or labeled as provided in this act.

Section 5. The following terms, wherever used in this act, or in rules and regulations later promulgated by the Commissioner of Agriculture, shall have the meaning as indicated:

1. "Mature" means that the outer skin (epidermis) does not loosen or "feather" readily during the ordinary methods of handling.

2. "Bright" means free from dirt or other foreign matter or discoloration fom any cause so that the outer skin (epidermis) has the attractive color normal for the variety.

3. "Smooth" means free from second growth, growth cracks and other abnormal, rough surfaces.

4. "Well shaped" means that normal, typical shape for the variety in the district where grown and free from pointed, dumb-bell shaped, excessively elongated and other ill-formed potatoes.

5. "Free from damage" means that the appearance shall not be injured to an extent readily apparent upon casual examination of the lot, and that any damage from the causes mentioned can be removed in the ordinary process of preparation for use without appreciable waste in addition to that which would occur if the potato were perfect. Loss of outer skin (epidermis) shall not be considered as an injury to the appearance.

6. "Diameter" means the greatest dimension at right angles to the longitudinal axis.

7. "Soft rot" means a soft, mushy condition of the tissues from whatever cause.

8. "Badly mishapen" means of such shape as to cause appreciable waste in the ordinary process of preparation for use in addition to that which would occur if the potato were perfect.

9. "Free from serious damage" means that any damage from the causes mentioned can be removed by the ordinary process of paring without increase in waste of more than ten per cent, by weight, over that which would occur if the potato were perfect.

10. "Container" or "Package" means cloth or fibre sack (such as is customarily used for the shipment of potatoes), barrel, box, crate, hamper or basket.

Section 6. When prepared for shipment in bags, baskets, barrel, box, hamper, or any other container, the same shall be tagged or labeled or branded legibly, designating the name and address of the dealer, shipper, corporation, society or association, or agent or representative, also the grade and net weight. When shipped as bulk, two cards conspicuously placed shall accompany such potatoes, which cards shall not be smaller than four and one-half inches by six inches in size, designating in letters not less than one-half inch in height the name and address of the shipper, the name of the grade, the car initial and number, and the date.

Dealers offering for sale, exposing for sale or selling potatoes from a vehicle shall designate the grade in the following manner: By a legibly printed tag on each container, or by a card not less than four and one-half inches by six inches in size, conspicuously placed upon,

or adjacent to, said potatoes, the letters to be not less than one-half inch high. Upon request of purchasers, the dealer must name the grade of potatoes sold to them.

It is further provided that this bill shall not apply to, or be construed to include, the sale of potatoes by the grower, made by himself personally or by an employe, direct to a consumer, or to a groceryman or company or copartnership conducting a grocery store: Provided, That when the operator of a grocery store shall purchase ungraded potatoes from a producer or grower, he shall have the right to display same for sale in open packages and sell same to the customer: Provided further, That a grocery keeper who buys from the grower ungraded potatoes and sells them as graded potatoes, under one of the qualifications of this act, shall be subject to the same fines and punishment as provided herein for violation of this act.

Section 7. The word "dealer" as used herein shall be construed to include any person, shipper, corporation, society, association, or their agent or representative. The act, omission or failure of any official or employe of any dealer, when such official or employe is acting within the scope of his employment or office, shall, in every case, be deemed also the act, omission or failure of the dealer as well as the official or employe.

Section 8. It shall be unlawful for any dealer to ship for sale, offer or consign for sale, or sell, potatoes which are not graded and branded in accordance with the provisions of this act and the regulations made hereunder, or have in his possession for sale any potatoes prepared for sale or sold which bear any false statement, design or device regarding the same, within the meaning of this act. In re-using any package or cover upon which appear any marks required by this act, or which were intended to describe the contents of the package, the dealer who is responsible for the re-use of such package or cover shall cause such marks to be removed, erased or obliterated before re-using. No person, except an authorized inspector of the State Department of Agriculture, shall alter, efface, or remove, or cause to be altered, effaced or removed, wholly or in part, any brands or marks required to be put upon packages under the provisions of this act, except in repacking, or to make the brands or marks correspond to the contents of the package.

Section 9. Any person, either principal or agent, who violates any of the provisions of this act, or the regulations promulgated hereunder, shall be deemed guilty of a misdemeanor, and, upon conviction thereof, shall be punished by a fine of not less than ten dollars, nor more than fifty dollars, for the first offense, and not more than one hundred dollars for each subsequent offense, or by imprisonment in the county jail for not more than thirty days in default of paying the fine, or both in the discretion of the court.

Section 10. It shall be the duty of the Commissioner of Agriculture to diligently enforce the provisions of this act, and his officers, inspectors, employes and agents are authorized to enter upon the premises of any person within this State for the purpose of inspecting potatoes and securing evidence of the violation of this act, and the said Commissioner of Agriculture is hereby authorized and empowered to make, promulate and enforce such regulations as may be necessary for interpreting the

grade specifications prescribed in this act, and for otherwise enforcing its provisions: Provided, however, That any grades, standards or classes for potatoes, or any requirements for marking packages containing potatoes which may hereafter be established by the authority of the Congress of the United States, and which are mandatory or optional as applying to interstate commerce, shall, or may, as far as applicable, be established and promulgated by the Commissioner of Agriculture as official grades, standards, classes and marks for potatoes packed or offered for sale in the State of Michigan.

THE EFFECTS OF BACILLARY WHITE DIARRHEA

Experiments Show Heavy Losses From This Disease in Poultry Flocks

HAROLD CANFIELD, POULTRY SECTION

Bacillary white diarrhea is probably the cause of greater losses and more discouragement to poultry raisers and hatcherymen than any other poultry disease.

By far the greatest losses from this disease occur among young chicks, from four to sixteen days old. The disease, however, may prove fatal at any age. Some of the chicks that become infected survive. Unfortunately, the survivors seldom succeed in freeing themselves from infection, remaining carriers of the disease as long as they live.

It has been found that yolks of eggs laid by infected hens frequently contain the organism producing bacillary white diarrhea. Chicks hatched from such eggs have the disease when hatched and usually die within three or four days. The disease is spread among the normal chicks by contaminated food or water. Healthy chicks may pick up droppings from infected chicks, and thus contract the disease.

Various remedies for this disease have been suggested at different times, but at present it is generally understood that there is no therapeutic treatment for bacillary white diarrhea that has very much practical value. The disease may be eliminated from a flock of poultry by applying the macroscopic agglutination test to all birds in the flock before the eggs are saved for hatching purposes. It is very important to remove all positively reacting birds from the flock as soon as possible after the test is made, because it is very likely that infection is spread among mature birds as well as young stock. This disease does not often produce any visable symptoms in mature stock, but it is generally believed that hens may become carriers of the disease after maturity.

In order to free an infected flock of hens from bacillary white diarrhea, it is necesary to repeat the test until no positively reacting

birds are found. Usually the test is made once each year, some time before the hatching season, until no reactors are found. However, some breeders get quicker results by testing twice each year. The first test is made during the fall or early winter, and the second test shortly before the hatching season.

The death of young chicks is by far the greatest loss caused by this disease, but there are other minor losses of sufficient importance to deserve mention.

Bacillary white diarrhea infection seems to reduce the vigor of mature fowls and make them more susceptible to other diseases, thus becoming the indirect cause of death of the birds.

The hatchability of eggs is very materially lowered by the presence of infection in the parent stock. The egg production of hens is also very much lowered by this disease.

A summary of the results of an experiment conducted by the writer during the past winter demonstrates these points very nicely. This summary shows a comparison of the performance of infected and non-infected birds from a certain flock of hens, considering egg production, hatchability of eggs, and livability of chicks.

Table Showing the Effect of Bacillary White Diarrhea Infection Upon Production, Hatchability of Eggs, and Livability of the Chicks

	Per Cent of Production	Per Cent of Eggs Hatchable	Per Cent of Livable Chicks
Infected hens	37.37	35.9	22.4
Non-infected hens	45.46	43.1	94.02

From the results of this experiment, it would appear that the infected hen would lay 136 eggs per year, while her uninfected sister is laying 166 eggs per year. There is a difference in production of 30 eggs per hen per year, between the two classes.

If the average price of eggs should be thirty-six cents per dozen, the infected hen would return each year ninety cents less than the uninfected hen. If only ten per cent of a flock were infected, there would be a loss of nine cents per bird for the entire flock because of the lowered production, which is one cent more than the usual charge made by laboratories making the blood test for bacillary white diarrhea, Therefore, the production loss alone, which is of minor importance as compared with the loss of young chicks, makes it worth while to eradicate this disease. The importance of eliminating the disease from the flock can scarcely be stressed too strongly. The loss of only one hundred day-old chicks would more than cover the cost of testing one hundred hens.

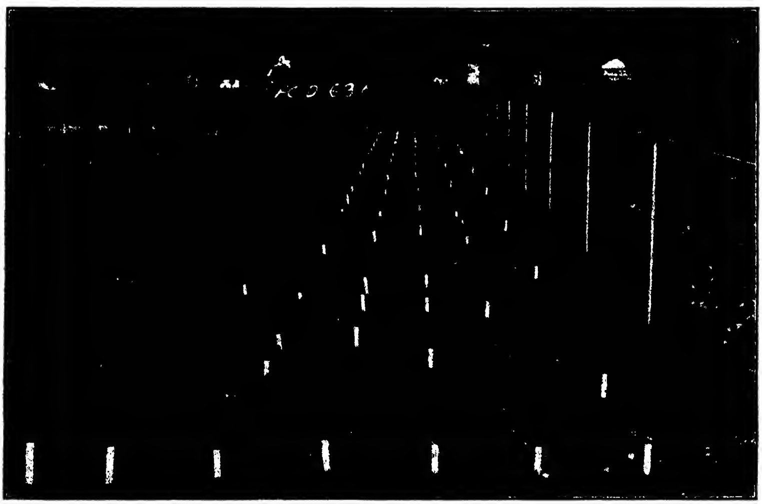
Abstract of thesis presented for M. S. Degree.

HASTENING BEET BREEDING OPERATIONS

Saving One Year in a Generation of Beets

E. E. DOWN AND C. A. LAVIS, FARM CROPS SECTION

Owing to the fact that sugar-beets normally produce seed only every second year, the plant-breeder who is working on this crop finds that his progress is comparatively slow, in that he can carry his material through only a part of a generation in a year's time. Breeding operations are at best relatively slow, and to work with a crop which produces seed only once in every two years greatly retards operations. A seed crop every year is desirable insofar as the breeder is concerned,



View of stecklings growing under overhead irrigation.

and a method of actually getting a seed crop every year has been worked out at the Michigan Experiment Station.

The ordinary method is to harvest the mother-beets in the fall, store them until spring, and then plant them for the production of a seed crop. As a result, a complete generation is obtained only once in two years. The present plan is to plant the mother-beet in the spring, harvest the seed as early as possible in the summer, and plant it at once in a plot which can be watered at will through the use of an overhead

irrigation system. The moisture conditions can be kept ideal for a rapid development of fair sized roots, before fall. These "stecklings," as these small mother-beets are called, are stored for the winter, and are ready to plant for seed production the following spring. The amount of seed produced by each of these small sized mother-beets may be somewhat less than that which is produced by a mature root, but it is enough to carry the strain on through the various breeding operations, and thus this method of seed production speeds up the breeding work.

Whether the production of these small, immature stecklings will influence the producing power of the progeny has not been fully determined, but these progenies do not appear to be less vigorous.

NITROGEN FIXATION BY NON-LEGUMINOUS PLANTS

BY R. M. SNYDER, BACTERIOLOGICAL SECTION

The agricultural press and agricultural experiment stations have familiarized the general public regarding the economic significance of the nodules on legumes. However, it will undoubtedly be news to many to learn that nodules are also to be found on some of the non-legumes. The study of this nodulation has been delayed for several reasons. In the first place, none of the nodulated non-legumes have any outstanding economic value at present. They tend as a rule to be woody—either small bushes or trees—slow growing, and unadaptable for forage purposes. Furthermore, the isolation of the organism from the nodule presents difficulties not to be found in the case of legumes.

The number of non-leguminous species in Michigan having nodules is unknown, due in part to our inadequate botanical knowledge of plant roots in general. The botanist in collecting plant specimens for his herbarium has been more interested in those parts of the plant above the ground, and has, as a general rule, ignored the root portions. It seems reasonable to believe that a little further study of this subject will show that we have at least twenty or twenty-five non-legumes in Michigan having nodules.

The two photographs show a Russian Olive tree on the M. S. C. Campus, and also nodules on the roots of the Russian Olive. This is one of the numerous examples of nodules on a non-legume. A study of the photograph will indicate that the general conformation of the nodular masses indicates a resemblance to the nodules on some of the legumes, such as alfalfa. The nodules on this Russian Olive and other non-legumes tend to be hard and tough, and not soft as in the case of the legumes. We do not know what organism causes these nodules on Russian Olive.

With two species, at least, isolation of causal organisms has been made from these non-leguminous nodules by Youngken, working with several species of Myrica; and by Bottomley, and later Petry, working

with Ceanothus americanus. Youngken obtained a fungus-like organism which apparently causes nodules on Myrica and is carried over from generation to generation in the seed. Petry finds a bacterium-like organism causing nodules on Ceanothus. It remains to be demonstrated whether the organism discovered by Bottomley is the same as that obtained by Petry, because Bottomley did not make inoculation tests.

The subject of the nitrogen relations is interesting. Petry, working

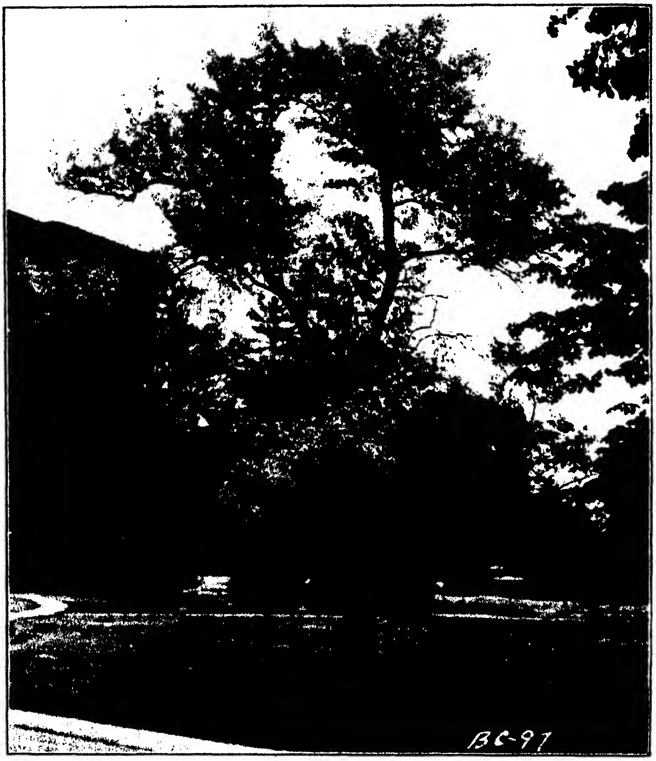


Fig. 1.—A Russian Olive Tree on the M. S. C. campus. This tree is a non-legume, but has nodules on its roots. The probabilities are that this tree is utilizing atmospheric nitrogen for its growth.

at the Michigan State College, found that nodulated Ceanothus plants had a higher nitrogen content than non-nodulate. In other words, we have a relation similar to that in the legumes. As to whether nodule bacteria from Ceanothus americanus (New Jersey Tea) can inoculate any other species of Ceanothus, or any other plant in another genus, remains to be proved.

In summing up, then, we may say that a number of non-leguminous plants, growing wild in the bogs and forests of Michigan, have nodules on their roots. We may state tentatively that these nodules are caused

by microorganisms, and that a nitrogen accumulating symbiosis is present, as in the case of the legumes and Ceanothus. Further work may demonstrate that some of these nodulate non-legumes are capable of economic adaptation.

Fig. 2.—A root of the Russian Olive, showing the nodular masses.

ADSORPTION AND SOIL ACIDITY

A Study of the Adsorption Factor in Soil Acidity

ELROY J. MILLER, CHEMICAL SECTION

The subject of soil acidity has probably received more attention than any other phase of soil investigation. Despite the enormous amount of work that has been done on the problem, the exact nature of soil acidity is still a matter of conjecture.

As far as the practical problem is concerned, it is dealt with to a large extent empirically through the addition to the soil of basic materials in the various forms of calcium carbonate (ground limestone), hydrated lime, and marl. Numerous methods are employed to test soils for acidity and to determine the proper amount of basic material to be added to the soil to correct the acidity. It is well known that in general these so-called "Lime Requirement" methods yield results that vary greatly, and no two methods give the same value for the degree of acidity or magnitude of the lime requirement. It is therefore imperative that further study be made to determine the nature of soil acidity and the underlying causes thereof, so that acid soils may be more intelligently handled, their conditions improved, and the further increase of acid soils prevented.

Soils are extremely complex in their composition and make-up, and so many factors are operative in them that it does not seem likely that any one simple theory will account for all the facts of soil acidity. As might be expected, the complexity of the soil has given rise to many contradictory ideas concerning the mechanism of the origin and nature of soil acidity. In view of these facts, it has seemed advisable to attempt to study separately the possible factors involved in the phenomenon. At present it is widely accepted that a considerable portion of the soil exists in the colloidal state, a condition in which the soil material is very finely divided and therefore has a relatively enormous surface. This matter in the colloidal condition is probably largely responsible for the physical and chemical properties of soils. It is supposed that the material in this condition has the property of removing from solution and holding on its surfaces soluble substances such as plant foods which otherwise would be rapidly leached away and lost in the drainage waters. This property of removing substances from solution and concentrating them on surfaces is known as adsorption.

Adsorption has long been considered as a possible factor in soils and in soil acidity, but the known facts concerning adsorption have them selves been so poorly understood and contradictory in nature that they have not greatly clarified our ideas of their possible role in soil acidity. Undoubtedly much of the difficulty arose through the fact that those

substances which possessed the greatest adsorptive power were very complex and far from being pure and well defined substances. It was evident, therefore, that for further progress along this line of investigation it was necessary to obtain adsorption data on pure substances. Such a material was prepared in this laboratory in the form of pure activated sugar charcoal. This charcoal is free from the inherent limitations of animal or blood charcoal on which much of the adsorption data existing in the literature on the subject has been obtained. With this charcoal extensive studies on adsorption from solution have been carried out. As a result of these studies, many new and important relationships have been established and many of the contradictory findings reported by previous investigators have been accounted for and explained.

A number of the properties of acid soils have been explained as due to hydrolytic or decomposition adsorption of salts by the soil colloids, a process in which a neutral salt is decomposed and either the acid or basic part adsorbed and removed from solution, thus producing an alkaline or an acid condition. The existence of hydrolytic adsorption itself, however, had never been conclusively demonstrated and the explanations, therefore, were not as generally accepted as they otherwise might have been. By means of this pure activated sugar charcoal it has been possible to obtain complete proof of the existence of hydrolytic adsorption, as well as much information pertaining to adsorption or surface concentration. This charcoal possesses many properties common to soils, and when it carries adsorbed acids on its surface its behavior is in many ways remarkably similar to that of acid soils.

With proof at hand that a substance as chemically inert as charcoal can actually decompose simple neutral salts and leave the solutions more acid or more alkaline, it becomes of interest to determine, if possible, whether the forces existing at the surface of the soil colloids act similarly. There are many facts which seem to indicate that soils do have the property of decomposing salts, and on the hypothesis that soils can decompose salts and adsorb acids, many of the well established facts of soil acidity can be explained. The same hypothesis would also seem to afford a logical explanation for the non-agreement of results obtained by the various lime requirement methods.

QUACK GRASS ERADICATION

R. S. HUDSON, FARM AND HORSE DEPARTMENT

A few years ago a farm lying immediately west of the college lands was purchased by the State Board of Agriculture as an addition to the college property. A part of this land was very light sand, which was pretty well sodded over with quack. It was reported that the quack had been seeded on this land by a former owner for the purpose of preventing the sand from blowing and drifting during heavy winds.

It will be observed that this prevalence of quack on the Michigan State College farm not only furnished a problem for myself as superintendent of field work at the college but also afforded an equipment with which to secure data which might help in answering some of the questions regarding quack grass.

Acordingly a 50 acre field containing the sand area referred to previously was divided into 8 areas upon which different cultural methods were used. Corn had been grown on the land in 1923, and the quack was so bad over a large part of the field as to materially reduce the yield of corn.

The following report will show the division of the field and indicate the work done with the results obtained as observed September 2, 1924, and again July 10, 1925.

Plot I

Fall plowed six inches deep October 15 to 20th, 1923.

Thoroughly fitted with disc harrow and spring tooth drag in April of 1924. Limed and seeded to oats and alfalfa April 20, 1924. Quack was very evident in thick patches July 10, 1925.

Plot II

Fall plowed eight inches deep October 23 to 27th, 1923.

Plowed three inches deep May 2, 1924. Harrowed five times with spring tooth drag at intervals of about ten days (every time grass appeared). Limed and seeded to alfalfa August 12, 1924. Quack seemed entirely killed and no evidence of reappearance July 10, 1925.

Plot III

Fall plowed three inches deep October 23 to November 4, 1923.

Plowed eight inches deep May 2, 1924. Harrowed five times with spring tooth drag at intervals of about ten days (every time grass appeared). Limed and seeded to alfalfa August 12, 1924. Quack seemed entirely killed and no evidence of reappearance July 10, 1925.

Plot IV

Fall plowed six inches deep October 24 to November 5, 1923. Disc harrowed six times at intervals of ten days (every time quack grass appeared). Limed and seeded to alfalfa August 12, 1924. Quack seemed entirely killed and no evidence of reappearance July 10, 1925.

Plot V

Fall plowed six inches deep October 24 to November 5, 1923. Harrowed eight times with Quack Grass Special tool No. 1. Limed and seeded to alfalfa August 12, 1924. Quack seemed entirely killed and no evidence of reappearance July 10, 1925.

Plot VI

Fall plowed six inches deep October 24 to November 5, 1923. Harrowed eight times with Quack Grass Special tool No. 2. Limed and seeded to alfalfa August 12, 1924. Quack grass seemed killed but soon reappeared in scattering clusters. By July 10, 1925 it could easily be discovered.

Plot VII

Spring plowed six inches deep May 20 to June 16, 1924. Harrowed with spring tooth five times, disc harrowed five times. Limed and seeded to alfalfa August 25th, 1924. Quack soon reappeared and was very evident in thick patches July 10, 1925.

Plot VIII

Same treatment as No. 7, but was not seeded to alfalfa. Was disc harrowed once and spring toothed six times after August 25, 1924. Piece was fall plowed six inches deep in late November, 1924. Spring plowed four inches in 1925 and planted to corn in hills. On July 10, 1925 the quack had entirely disappeared.

Conclusion

1. Summer fallowing on fall plowed land is a more reliable method for eradicating quack than summer fallowing on spring plowed land.
2. Seeding a crop before quack is entirely dead will result in failure in ridding a farm of quack grass.
3. Fall plowing and seeding to a spring crop, either cultivated or uncultivated, will not eradicate quack.
4. Special tools are not necessary. Thorough use of a plow, spring tooth drag, or a disc harrow will kill quack grass.
5. Success in the destruction of quack grass requires frequent and thorough cultivation, no matter which method is used.

FARMERS' CO-OPERATIVE CONCERNS IN MICHIGAN

Review of Development Shows Sound and Progressive Basis

W. O. HEDRICK, ECONOMICS SECTION

Farmers in Michigan have commonly undertaken to co-operate for business purposes in the handling of telephone exchanges, insurance companies, creameries, breeding associations, mercantile stores, marketing exchanges, credit associations, and milk distribution. They have also had many minor neighborhood associations as the result of co-operative action, such as the community ownership of machinery, the maintenance of "meat-rings," "egg circles," and other instances of less note.

The setting up of co-operative associations in Michigan has been in almost every case the result of a local or neighborhood activity. No general co-operative movement has swept over the state, creating a fever for these associations. On the contrary, Michigan associations and associations generally have had separate and isolated beginnings, coming into being in some community or another only as concerted action could no longer be avoided, in order to destroy bad conditions, or to implant new and better ones. It is this spontaniety of origin, this outgrowth from necessity, which apparently assures the success and the stability of these associations so long as they continue to serve a useful purpose.

The state from the farm point of view has many marked traits, the common description of the agriculture carried on in Michigan being that of "general farming shot through with specialties." It is to this very fact of highly specialized farms that unusual sorts of co-operative associations which are to be found in the state may be accounted for. Associations, such as those of celery growers, are good examples, and doubtless we may fully expect that the growers of others of our specialties, such as chicory, mint, and cranberries, and the beekeepers, will soon learn the merits of associated marketing. A tabular showing of the status of co-operative marketing concerns in Michigan is as follows:

Both peninsulas of the state together have more than 500 co-operatives of the marketing variety:

Livestock shipping Associations, 200; Produce Exchanges, 167; Grain Elevators, 140; Creameries, 70.

Some of these are in the third decade of prosperity. All of them are, or have been federated into state associations.

The beginnings of co-operative effort among farmers in Michigan were in the form of Grange stores, which flourished in the state in the '80's and '90's. Here, as in other states where the Grangers succeeded in building themselves up, the history of these stores was almost always

the same. Set up in the fervor of the early spread of co-operative effort among Grange farmers, they often lacked every element needed for successful store keeping, and their failure was certain from the start. By the year 1900, not a single one of these stores was left in the state, and the merits of co-operation among farmers had sunk very low in the public mind as a result of these failures. The word co-operation, itself, was a shame and a reproach wherever it was named.

A new type of co-operation among farmers—the marketing exchanges—which followed the Grange stores, were more certain of success. They are the selling side of farming itself; hence the farmer has taken more interest in them than he did in stores which belong to a different pursuit from farming. Even the improved means of communication—telephone, motor truck, motor car, etc.,—of recent date have been strong make-weights for the success of farmers' co-operation.

As is well known, the crucial tests of an association of farmers as to whether it is co-operative or not depends upon the way benefits are distributed and the way control is kept up. "Patronage dividends" as a means of sharing the benefits from co-operation, and "one man one vote" as a means of control, are the watch words of true co-operation. Four laws, at least, of the many statutes for organizing corporations in this state have emphasized the "one man one vote" and "patronage dividends" feature of co-operation.

Many of the same advantages which come to a farmer from joining a co-operative concern come also to the association from uniting with other associations of its class into what is called a federation. One of the oldest of these federations in Michigan is the Potato Growers Exchange, with headquarters at Cadillac. The sixth and latest annual report of this well known central exchange shows a membership of 105 active local exchanges and a total amount of business for the year reported upon of over $1,800,000. More than three thousand cars of potatoes were shipped during the year and the expense to the potato shipper was about six cents per hundred for having his shipments made for him.

The most popular commodity throughout the country for co-operative marketing is grain, and the co-operative grain elevator companies of Michigan have their federation also in the Michigan Elevator Exchange, under the same roof with the Michigan Farm Bureau, located in Lansing. This central exchange is now half a decade old and did a business in selling the products for its members of nearly $8,000,000 during the last year. More than a hundred elevators made up the membership of this federation, and since these are among the most expensive types of co-operative agencies, a large amount of capital is represented by this large exchange.

No other form of local co-operation is so common in Michigan as the livestock shipping associations, since these require little initial capital with which to start, are easily managed, and deal in a very costly product. The Michigan Livestock Exchange of Detroit represents these locals upon the livestock market of the country in disposing of products of this sort to the best advantage. More than a million and a half dollars worth were handled by this "central" last year. Another of these state-wide marketing associations, and one also situated in

the city of Detroit, is the Michigan Milk Producer's Association. This is easily the largest of the associations of the state in point of membership, counting at one time more than 12,000 members. Among its many other services is that of the sale of milk for its co-operators upon the Detroit market. It was organized in 1916 and has had many successes, notably that of never having had one of those costly "milk strikes" or other disturbances—even during the Great War period—which have so greatly marred the milk trade in most of the other large cities of the land.

Most recently the fruit or produce concerns have banded together into a federation under the name of the Michigan Fruit Growers Corporation, with central offices at Benton Harbor. Since fruit and produce co-operative societies have been among the oldest and most successful of these concerns which the state has afforded, and since these sorts of products are peculiarly adopted to co-operative marketing, it is easy to forecast for this latest effort the same success that the older ones have had. The whole situation, with regard to co-operation in Michigan, can be looked upon in no other way except that of being on a sound and progressive basis.

THE STATUS OF AGRICULTURAL CO-OPERATION IN THE UNITED STATES

W. O. HEDRICK, ECONOMICS SECTION

Co-operative marketing among farmers has apparently passed the stage of doubt and experiment in this country and has reached a place of solid and enduring approval. A summary of the present status of these associations in respect to membership and distribution, as of January 1, 1925, has been made by the U. S. Department of Agriculture, and is as follows:

Two and one-half million members is the estimate for the ten thousand active farmers' business organizations reporting to the U. S. Department of Agriculture, upon the date named above.

Ass'n. Marketing Grain, 500,000; Ass'n. Marketing Dairy Products, 360,000; Ass'n. Marketing Cotton, 320,000; Ass'n. Marketing Livestock, 300,000; Ass'n. Marketing Fruits and Vegetables, 210,000; Ass'n. Marketing Poultry Products, 45,000; Ass'n. Marketing Tobacco, 300,000; Ass'n. Marketing Wool, 45,000; Ass'n. Marketing Nuts, 23,000.

The associations handling a miscellaneous line of products and performing miscellaneous functions had an estimated membership of 397,000.

Nearly one-half (46.5%) of the membership named above was in the twelve North Central States. Slightly over 23% of the total membership was in the eight South Central States. Between 13% and 14% of the total number of members were in the South Atlantic States, stretching from Delaware to Florida. Less than 3% were in the Mountain States and a trifle over 2% in the New England group of states.

MAKING GOOD APPLE CIDER

Clean Barrels and Sound Apples Essential for Quality Product

F. W. FABIAN, BACTERIOLOGICAL SECTION

Many people, appreciating the demand for cider, are realizing a nice profit from cull and surplus apples by turning them into cider. This is especially true of those located near a sizable town. The practice is in accord with the truth generally recognized in business that often the margin of profit is greatly increased, or in some cases made entirely, by utilizing the by-products.

There are a few basic principles that should be followed in making good cider. The first of these involves using a clean barrel. More cider is spoiled every year by the use of musty and dirty barrels than in any other way. If it is not spoiled outright, the taste of the cider is greatly impaired by the use of such barrels. One of the best ways to clean a barrel is by first soaking and rinsing it, and then steaming it thoroughly. In many cases, the farmer thinks that steaming is all that is necessary and he fails to rinse and soak the barrel thoroughly before steaming it.

Another good way to clean a barrel is to rinse and soak it, and then add two or three tablespoonfuls of chloride of lime. This will kill the harmful organisms and "sweeten" the barrel. One precaution should be observed here, and that is to rinse all the chemical out of the barrel otherwise it will keep the cider from fermenting and turning to vinegar.

The next essential thing to observe is the kind of apples. In the first place, rotten or partly rotten apples should never be used. This practice is unsanitary, unlawful, and uneconomical. The Michigan State Department of Agriculture has a ruling against using rotten apples for cider. It is uneconomical, because all the food in a rotten apple has been used up and there is nothing left for cider. Finally, rotten apples impart an undesirable taste to the cider, and no matter whether it is to be used for drinking or vinegar it still has the flavor.

The variety of apples also makes a big difference. In general, summer and early fall apples are less desirable than the later varieties. Sweet apples are not as desirable as might appear for cider for several reasons. They do not necessarily have more sugar than sour apples, but they do have less acid. It is the lack of the acid rather than the presence of sugar that gives them the sweet taste. This lack of acid is also the reason why sweet apple cider spoils more readily than sour apple cider. Certain undesirable organisms are able to thrive in it that are not able to live in sour apple cider.

If you desire to keep cider from fermenting or turning "hard," two methods are available. The first method is to heat it in bottles up to

a temperature of 145° F. and hold it there for thirty minutes. Cork it up tight and set in a cool, dry place. Another method is by using 0.1 per cent benzoate of soda and keeping in a cool, dry place. Cider treated by either method will keep for considerable periods of time, but it must be kept cool.

In summing up: To produce good cider use a good clean barrel, thoroughly cleaning it by soaking, rinsing, and then steaming or treating with chloride of lime. Next use good sound apples, preferably winter apples of proper variety. Finally, to keep cider from fermenting, heat to 145° F. and hold for thirty minutes, or add 0.1 per cent benzoate of soda.

Note: For detailed information on how to convert cider into vinegar, send for Michigan Experiment Station Bulletin 98.

THE BACTERIOLOGICAL BACKGROUND OF BUTTERMAKING

III. Factory Treatment of Cream

G. L. A. RUEHLE, BACTERIOLOGICAL SECTION

Cream may be spoiled for buttermaking before it reaches the creamery. This is so well known, that the practice of grading cream as received has been practiced by the better creameries for some time. A previous article dealt briefly with the factors concerned in the spoilage of cream while still in the hands of the farmer. It should be borne in mind that cream can also be made unfit for buttermaking after it is delivered by the farmer, and all of the practices of the buttermaker should be designed to control the desirable fermentations of the cream and to prevent or minimize the effects of the undesirable ones.

The same factors concerned in the spoilage of cream while it is in the farmer's hands also apply in the creamery and a few in addition. It is just as essential here as on the farm that all utensils and apparatus which come into contact with the cream or butter be as nearly sterile as it is practicable to make them. To do this, it is necessary, first, to mechanically remove as much grease and dirt as possible by thorough washing with warm water and alkali. This cleansing process removes food for bacteria and probably over 90 per cent of the bacteria themselves. The most of the remaining bacteria are then killed by steaming thoroughly or by sufficient contact with boiling water. There really are two objects in the steaming or scalding. The application of moist heat kills most of the bacteria remaining after washing and then hinders the small number still alive from developing by removal of the moisture. This is because water evaporates more readily from a hot surface than from a cool one. Once the utensil is thoroughly dry, very little bac-

terial growth can take place, since bacteria need water the same as other living things. Among the equipment and utensils requiring special care are the sanitary piping and the churns. Sanitary pipes should be allowed to dry out after cleaning, unless they are to be used immediately.

The churn is perhaps the most difficult of all utensils to sterilize, because it is made of wood, which is certain to be more or less porous. Hunziker states that churns may be rendered less porous by treatment with milk of lime. This also has a marked antiseptic action and is a good deodorizer. Hunziker states that for a new churn the milk of lime solution should be allowed to remain in the churn for three days to remove the woody odor. Occasionally, the churn should be revolved so that all parts may come into contact with the lime. After removal of the lime solution, the churn should be rinsed in several changes of water, the last of which should be boiling hot. This last will have a decided effect in reducing the number of micro-organisms in the churn. Since the churn must not be allowed to dry out, the final rinsings should be done just before the churn is to be cooled for the reception of the cream. That is, the period between sterilization and its use as a receptacle for cream should be as short as possible to prevent the growth of any bacteria which have not been killed by the lime and boiling water treatment. This same treatment is also applicable to farm churns and to other churns which have stood idle for a period of time.

Churns which are in constant use should also be frequently sterilized but obviously they cannot be allowed to stand idle for three days. In this case an overnight soaking, followed by the rinsings with cold and hot water, should be sufficient.

Other sources of bacteria, which are not so important from the standpoint of numbers of bacteria which they add, but which are important from the standpoint of the kinds of bacteria which they contain, are: (1) the water used in washing and rinsing utensils and in washing butter, (2) the hands and arms of the workers who handle the butter, (3) the paper used in wrapping, and (4) the salt which is added to the butter. The amount of contamination from each of these sources can be minimized though not entirely eliminated. If the water contains excessive amounts of organic matter, it will add relatively greater numbers of bacteria than would pure water. Of course, the ideal water supply would be one which contains little organic matter and few microorganisms as well as a minimal content of iron and other heavy metals. Where it is not possible to get a bacteriologically pure water supply, one must resort to purification.

Heating the water to the temperature of pasteurization or even to boiling and then cooling is practiced successfully by some creameries. This requires considerable equipment and power, but is worth while where it can be done. Other methods, such as filtration and treatment with ultra violet rays, are probably not practicable at the present time.

The hands of the worker may contribute very undesirable or even dangerous bacteria to butter. The practice of removing butter from the churn with the bare hands is very reprehensible from the standpoint of sanitation and disgusting from the esthetic standpoint. There is no reason why the worker should not be supplied with long-sleeved rubber

gloves, which can be readily sterilized by placing them in a solution of milk of lime when not in use.

The paper used for liners and for wrapping prints of butter frequently is contaminated with moulds and bacteria. This can be sterilized by immersion in a boiling, saturated solution of butter salt in water. The salt incorporated into the butter only occasionally contributes many bacteria. This happens where the salt barrels are left exposed to dust in a damp, musty place. The kinds of micro-organisms added are of a very undesirable type for buttermaking, since they cause liquefaction of casein with the production of off flavors.

Up to this point we have been considering methods of keeping cream from becoming contaminated with bacteria. For the control of the bacteria already present, we have two means at hand. One is low temperature, which lessens the rate of multiplication of the bacteria. The other is the application of heat, as in pasteurization, which kills bacteria. It may be assumed that no buttermaker needs any advice about keeping cream and butter cold, since it has become the universal practice to do so.

On the other hand, pasteurization does call for some comment. By means of pasteurization, the cream is freed from live bacteria and already formed enzymes, as nearly as possible. In the case of pasteurization of milk in the market milk trade, great care must be exercised to prevent overheating, as the latter interferes with the creaming. In pasteurization of cream for buttermaking, the creaming obviously is of no importance. Moreover, the enzymes of cream are not destroyed or inactivated until a temperature of 176° F. is attained. Therefore, a flash temperature of 180° F. is recommended. This means heating the cream to 180° F. and cooling immediately to churning temperature in case sweet cream butter is to be manufactured, or to 65° F.-70° F. in case the cream is to be ripened with starter. One defect in pasteurization by the holding method should be noted at this point. Frequently the cream which is contained in the piping leading to the gate of the pasteurizer is left undisturbed and therefore not heated to the required temperature. A bucket full of cream should be removed from the gate several times and poured into the main body of cream.

Sour cream should not be pasteurized until after the acid has been neutralized, since undesirable off flavors result from the heating of sour cream. This at once raises the question of the ethics of neutralization of cream. This and the methods of neutralization are beyond the scope of the present article and will not be discussed. The use of starters also will not be discussed in detail in the present article, although it might properly be included, since the starter is added for the purpose of innoculating the cream with a desirable type of bacteria. Only a good fresh starter properly prepared from sterile or nearly sterile milk should be used in buttermaking. Since a starter is merely a culture of bacteria of a more or less desirable type, it is obvious that old starters, which are really cultures of dead bacteria, are worse than useless. Also starters which are no longer pure may be the source of very undesirable types of bacteria.

A RECENT HYGIENIC SURVEY OF DAIRY PRACTICES ON GENERAL FARMS*

Acknowledgment

The writer is indebted to Mr. G. L. A. Ruehle for helpful criticism and advice.

BY DONALD BETHUNE SHUTT, BACTERIOLOGICAL SECTION

In spite of all the work that has been done on the improvement of dairy methods, it is still easy to find communities which have changed their methods but little since the pioneer days of agriculture. This is but another illustration of the fact that scientific research is frequently from ten to thirty years ahead of practice. This fact was forcibly brought to the writer's attention in a recent sanitary survey of the milk shed of a plant manufacturing dairy products. The information gained in this sanitary survey is given below with the hope that it may be of interest to others.

Of a total of 201 farms inspected only 1,332 cows were found, making an average per farm of only 6.62 cows, a comparatively low figure. The herds were mixtures mainly of Holstein, Shorthorn and Jersey. A few were of one breed only, most of these being Holsteins. No pure bred herds were found, although a few herds were sired by pure bred bulls. Only one farm was found where a pure bred herd was being developed. No attempts have been made to determine the yield of milk or of butter fat per cow on any of the farms, though all the cows have been tuberculin tested under the co-operative area plan. Many of the cows probably would prove to be unprofitable, if their production records were kept.

The stables showed great variation. One hundred and ninety-four were located upon the barn floor with in some instances, an inadequate wooden partition separating them from the barn proper. One hundred and forty-nine of these had horses stabled with the cows. Other live stock such as hogs and chickens were occasionally found with the cows. In all of these stables the cows were tied up in stalls. Seven basement stables were found, all but one of which housed cattle only, while one had horses as well. One farm had a modern dairy barn for its herd. On the other hand, five very primitive stables were located, the cattle being housed in nothing more than a manure shed and consequently were in a hopelessly filthy condition; the explanation given for these conditions was that it was not natural to tie up cows.

One hundred and twenty stables had proper concrete floors and gutters, the remainder had the original earth or elevated wooden floors. Of the latter only a few provided a gutter, the others trusted to luck and the cracks in the floor to remove surplus moisture. In consequence the ground beneath was far from sanitary.

Regarding light, only twenty-five barns had four square feet of window space per cow. The great majority had less than two square feet. A few had no light at all except that which filtered through the cracks of the walls.

There were only nine attempts at proper ventilation. These had flue systems of various kinds. The remainder depended upon the loose construction of the ceiling, or windows and doors to supply the need. Most of these reported cold stables in winter. Only two stables were found with damp walls and ceilings; one of these was quite moldy and the atmosphere was very uncomfortable to humans.

There was a considerable variety in the methods employed to dispose of the manure, most of which was thrown in a pile just outside of the door. Fifty-one farms had manure sheds, which were usually located beside the stable and greatly obstructed the lighting arrangements. A considerable number had loosely constructed partitions that allowed the odors to penetrate into the stable.

The pails used in the milking were with only a few exceptions very clean and were scalded with hot water before use. Two farmers kept their pails in the stable. These were none too clean. Small top milking pails were found on only two farms. Clean milking suits were unknown although one farmer wore a clean apron during milking, while the remainder wore their work clothes. The cans were washed and steamed at the plant and returned daily by the hauler.

Only three farmers made a practice of washing and drying the udder, or going over it with a damp cloth before milking. Sixty-five resorted to brushes or burlap sacking to remove visible dirt before milking. Twenty-three milked with wet or damp hands, the majority of whom dampened the hands to begin milking, taking the milk from the teat, while the remainder replenished the moisture needed with froth from the pail. Almost all claimed to wash their hands before milking.

The predominating cooling system was the simple method of placing the milk can in a tub of cold water and agitating the milk. Only three tin coolers were located, one of which was rusty, but the other two were in good condition. Ice for cooling was found on only one farm and a running spring on another.

Only sixteen milk houses were found out of a total of two hundred and one farms. The majority of these were of concrete construction with cooling tanks built in, the remainder being wood. Only two milk houses were equipped with steam boilers. These had arrangements for washing utensils with cold and hot water and for steaming them.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, East Lansing, Michigan.

LIST OF AVAILABLE BULLETINS

Regular Bulletins—

251 Insects of 1907.
258 Insects of Field Crops.
262 Suggestions on Planting an Orchard.
264 Second Report of Grade Dairy Herd.
267 Michigan Weeds (only to libraries and teachers).
273 Utilization of Muck Lands.
277 Studies in the Cost of Market Milk Production.
281 Trees, Shrubs and Plants for Farm and Home Planting.
284 Some Information and Suggestions Concerning the Use of Phosphorus.
286 Studies and Cost of Milk Production—No. 2.
289 Corn Growing in Michigan.
290 Soil Fertility.

Special Bulletins—

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65 Hog Cholera and Preventive Treatment.
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70 Michigan Agriculture, Its Present Status and Wonderful Possibilities.
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82 Durability of Concrete Drain Tile No. II.
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56 Lime Requirement for Cass County.
57 Lime Requirement for Calhoun County.

*The names of new bulletins published since the November Quarterly Bulletin are starred and printed in heavier type.

58 Lime Requirement for Berrien County.
59 Lime Requirement for Ottawa County.
60 Lime Requirement for Kalamazoo County.
61 Paying for Milk on a Quality Basis as a Means of Improving the Supply.
62 The Simplex Lime Spreader.
63 White Ants.
64 Simple Water Systems.
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66 *Tests with Sugar Beets.

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58 The Occurrence of Protozoa in Plants Affected with Mosaic an Related Diseases.
59 Flat Sours.
60 The Influence of Manufacturing Operations on the Bacterial Content of Ice Cream.
61 The Relation of High Cellular Counts to Bacterium Abortus Infection of the Udder.
62 Some Physical and Chemical Properties of Several Soil Profiles
63 A Study of the Early Blight Fungus, Cercospora Apii Fres.
64 The Salt Requirements of Marquis Wheat in Water Culture fo the Vegetative Phase of Development.
65 Studies on a Non-Virulent Living Culture of Bact. Abortus wards Protective Vaccination of Cattle Against Bovine Infectious Abortus (Bang's Abortion Disease)
66 The Significance of Bacterium Abortus Antibodies (Agglutin and Complement-fixing) Found in the Sera of Calves at Birth After Nursing.

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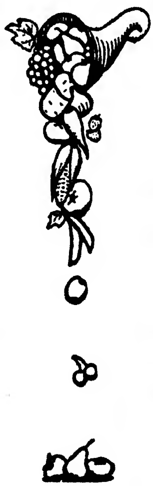

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MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN
Vol. 8, No. 2, November, 1925

THE EUROPEAN CORN BORER*

This Serious New Pest is making Rapid Progress through Michigan's Corn Belt

R. H. PETTIT, ENTOMOLOGICAL SECTION

At the present moment, Michigan and for that matter all of the United States, is threatened by a danger to her agriculture which we believe has never been paralleled. The European corn borer is here; it is steadily gaining ground and nothing which we have done, or can do, can prevent the pest from eventually establishing itself, at least wherever corn is grown. Nevertheless, *we must raise corn in spite of this new enemy to our agriculture.* Corn is distinctly an American crop and on our national corn crop depends our prosperity, in large measure. We depend on corn for the success of our livestock industries which supply our pork, wool, meats of all sorts, milk, and many manufactured food products. Failure to raise corn at a reasonable cost would result in a complete revision of our agricultural program.

Fig. 1.—A piece of cornstalk showing corn borers and the kind of work they do.

In order to understand and to visualize the enormous potentialities for destruction possessed by this insect, one has but to visit fields raised according to existing practices in districts where the pest has been established for several years, and where it has not

*Excerpts from Michigan Circular Bulletin No. 70, "The Present Status of the European Corn Borer in Michigan."

been restricted by the practice of measures aimed at minimizing the loss. Such fields, and in fact areas of large size are to be found in parts of Ontario within a distance of thirty miles east of Detroit. Possibly the worst damage has occurred in this section up to the present time, and cases occur there where fields show a total loss. The inference is clear. We must all get behind a movement to inform the grower as to just what changes are necessary in agricultural practice in order to "get by" with the least loss and to inform the tourist, the traveller, and in fact every citizen of the nation, of the serious and far-reaching consequences which are sure to follow the introduction of borers into new localities, and the consequent spread of this new enemy.

The borer was first introduced into this country sometime in 1909-10 in a shipment of broom-corn from Hungary and Italy.

In its native home the borer has natural enemies or parasites which keep it within bounds most of the time. Since these natural enemies did not exist in this country, they have been imported and increased under control as an aid in combating this serious pest. This work, however, is just in its infancy and much remains to be done. At the best, too much should not be expected, for the present at least, of this means of control.

The Quarantine

Up to the present, the most effective measure that has operated in Michigan to the disadvantage of the borer, has been the quarantine, which aims to slow up what otherwise would be the natural spread of the insects and to prevent spread over long distances, which might result from the carrying of corn or other infested products to new districts. A very successful attempt has been made through co-operation of the national Bureau of Entomology and the State Department of Agriculture to prevent the carrying of infested corn into uninfested districts, thus minimizing the danger of establishing new foci of infestation.

Very little comment is called for in this connection. We are familiar with the stopping of cars and the searches for corn which have undoubtedly resulted in preventing the establishment of many new areas of infestation as witnessed by the actual finding of infested ears in the corn confiscated. The continuance of the quarantine is assured; the line will naturally move to the west to accommodate itself to the line of demarcation between infested and uninfested districts.

The measures or farm practices which have given the best results thus far are to be learned by experience in other states and in Canada. Michigan has thus far suffered very little real loss since it is passing through the stage of original occupation.

Practices Recommended for the Restriction of the Corn-Borer

Cut early. Just as soon as the corn is ripe, cut it and remove from the field. Put as much as may be possible into the silo, since the fermentation in the silo kills all the insects.

Cut low. No infested corn should be cut more than three inches high and if possible get it down to one inch. The larvae tunnel

downward toward the end of the season and naturally the butt of the stalk remains moist and edible to the last.

Destroy by fire or deep plowing all unused remnants of corn cobs and any stalks not shredded, by May 15, or by June 1 at the very latest. Corn run through the cutting-box should be plowed under at this time. If stalks are fed whole, do not place the uneaten parts of the stalks on the manure pile to rot since very many larvae will escape if this is done. Pile them and then draw them to the field and burn.

Equip the corncrib with wire mosquito-netting and keep the door closed. Be sure the door fits tightly. There are sure to be some larvae in the cobs.

Plow the stubble late in the autumn, after November 15, if possible. In many seasons this will not be possible because of cold weather but it can be done part of the time. After plowing either stubble or any other form of corn waste, do not drag with a toothed harrow but use a disc. The plowing must be deep and all remnants must be covered.

Whenever weather conditions do not permit late fall plowing, spring plowing carefully and cleanly done seems well worth while, even if it is not so effective as fall plowing.

Observe both the letter and the law of the quarantine. The one ear of selected seed sent by mail or transported in any way might easily cost the nation a million dollars by starting a new focus ahead of its natural time.

Some of the common insects which are often confused with the corn-borer are the corn ear-worm, fall army-worm, the common stalk-borer, as well as the broken-lined Hadena.

More detailed information regarding this serious pest is given in Michigan Circular Bulletin No. 70, copies of which may be secured upon request to R. S. Shaw, Director, East Lansing, Michigan.

NEW APPLE VARIETIES

A Report on Trials at East Lansing With Some of the Newer Varieties

R. E. LOREE, HORTICULTURAL SECTION

In the spring of 1915 trees of several varieties of apples which were originated by the New York Agricultural Experiment Station at Geneva were planted on the station grounds at East Lansing. The list included Clinton, Cortland, Chautauqua, Herkimer, Montgomery, Nassau, Onondaga, Oswego, Rennsalaer, Schenectady, Scoharie, Tioga, Ulster, and Westchester. They were planted on a rather heavy clay loam. With the exception of Ulster the trees have made a very satis-

factory growth, and all except Tioga and Oswego have borne some fruit. In general, the trees are all that can be desired. They are healthy, vigorous, upright spreading in habit, and some of them are very productive. However, most of these varieties are notably lacking in one or more fruit characters. Some are of the Ben Davis type, resembling it in color of the skin and in the quality of the flesh. Of those which have borne fruit only two—Westchester and Scoharie—possess qualities which commend them for further testing.

Westchester is one of the most productive of the lot and though the general appearance of the fruit is not attractive it is of desirable size and flavor. In season it is intermediate between McIntosh and Northern Spy and in ordinary storage it keeps until March or later. It may prove valuable as a home orchard or a local market variety.

The fruit and tree of Scoharie resemble Northern Spy, but the fruit is less highly colored. The flesh is yellowish, firm, fine grained and juicy with all the flavor and aroma of the Spy; the fruit is good for either dessert or cooking. It ripens with Northern Spy but under favorable conditions keeps longer in storage. The tree blooms about the same time as the Northern Spy and it may be found desirable for planting on a limited scale in commercial orchards as a pollenizer for that variety. Further testing is necessary to establish its value.

Recently the Cortland has received considerable attention, and it has been highly recommended to the growers of some states. In appearance it somewhat resembles the McIntosh. However, any careful observer can easily distinguish it from that variety; furthermore, one taste of the flesh is sufficient to identify it as different. The fruit ripens later, hangs well to the tree and keeps longer than McIntosh, but under Michigan conditions it is decidedly inferior in quality. It cannot be recommended for planting in this state.

Other varieties which have been tested recently are Summer Champion, Peerless, Mammoth Grimes, Magnet, Fort's Prize, Estelline, Magoon, Henry Clay, King David and W. H. S. None of these appear promising for Michigan growers. Mammoth Grimes is a greenish yellow apple, larger than Grimes, but it is distinctly different in shape and bears little resemblance to it either in appearance or in quality. Henry Clay is an early variety which ripens with Red Astrachan. It is a large green apple which resembles Rhode Island Greening and is excellent for cooking. The tree is a shy bearer and the variety is not recommended.

King David has been rather extensively planted in Michigan. By some it is known as Improved Jonathan, but it falls far short of equalling that variety. The fruit is darker though it does not possess the bright attractive red of the Jonathan. The flesh is yellowish, somewhat coarse, very tart, and has a tendency to "break down" in the center if the fruit is held long in storage. Furthermore, much of the fruit is undersized and the trees do not rank high in productiveness. Further planting of King David does not seem warranted, and in many cases it will be found advisable to topwork those already planted to more desirable varieties.

WINTER MANAGEMENT OF THE POULTRY FLOCK

Correct Breeding, Feeding, Housing, and Culling are the Cornerstones for Profitable Production Throughout the Fall and Winter Months

J. A. HANNAH, POULTRY SECTION

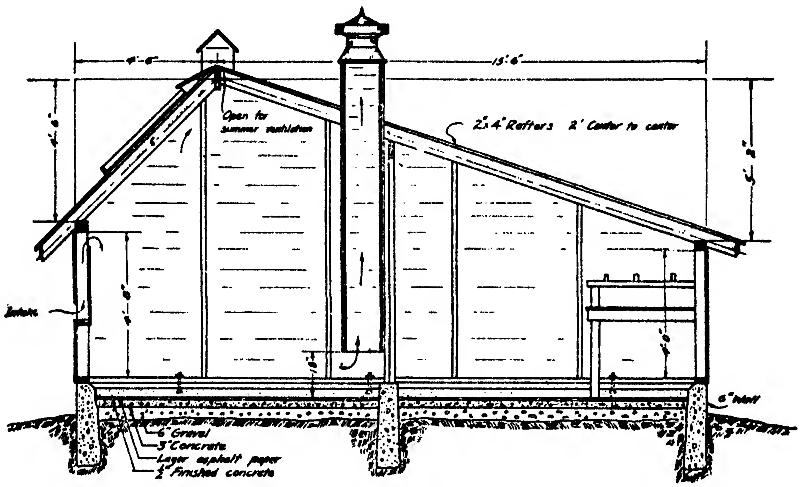
Profitable poultry production depends largely upon winter egg yield. The difference between the profitable and the unprofitable farm flock usually is winter production. On the poultry demonstration farms being conducted in cooperation with the Poultry Department, it has been found that the monthly feed cost per bird remains relatively constant. In the year 1924-25 it varied from 12½ cents to 13½ cents per month, varying less than one cent from high to low point. It can be seen readily that if it costs as much to feed a hen in June as it does in November, and if the average egg price is 28 cents per dozen in June, and 55 cents in November, the fall is the time to run up the greatest profit from the poultry flock.

With our present knowledge of breeding, feeding, housing, and culling, it is possible to obtain heavy production throughout the fall and winter months. In the fall the breeding of the stock on hand cannot be changed, but the birds can be well culled for production, those plainly lacking the ability to lay profitably eliminated. Feeding and the housing conditions are the chief factors determining the number of winter eggs produced. Regardless of the breeding or of the apparent ability of a bird to lay, she can not do so, unless she is properly fed and housed. To obtain winter production, it is necessary that the flock be fed dry mash in open hoppers continuously, allowing the birds to eat as much as they will. A satisfactory mash may be prepared by mixing equal parts by weight of bran, wheat middlings, corn meal, ground oats, and meat scrap, plus one per cent (by weight) of salt, and two per cent of either dried marl or ground limestone. In addition to the mash in open hoppers, the birds should be fed a scratch grain consisting of equal parts by weight of whole wheat and cracked corn; this grain may be fed in a deep litter of straw once or twice a day, preferably in late afternoon, and the birds should receive about all they will clean up nicely in 20 to 30 minutes. In severe cold weather it is well to scatter a little grain in the litter several times during the day to keep the birds busy.

If the pullets are late, and slow in coming into production, or if the old hens are slow in coming back after their moult, artificial lights will help materially and the day should be lengthened, to not over fourteen hours. In addition, wet mash, given at the rate of from three to five pounds (weighed dry) to one hundred birds, will, in many cases, hasten pullets into production. This should be fed at noon each day,

until the birds are laying 25 to 30 per cent or better; then it can be tapered off, less and less being given each day. It must be understood that a wet mash is not a substitute for the dry mash; the birds should be allowed access to the dry mash hoppers continuously. It has been found that a flock will eat about as much dry mash and scratch grain as they were eating before, and will eat the wet mash in addition.

Green feed is important; in fact successful poultrymen consider green feed as important as mash or scratch grain, and make sure that their flocks have all the green feed they will eat daily. For winter feeding, sprouted oats is the most desirable green feed. The oats should be soaked in water for twenty four hours, spread in shallow boxes, and



SECTION of END
SCALE ¼"=1'-0"

Fig. 2.—Cross section view of Michigan type poultry house, showing ventilator intake and outlet. Proper dropping board arrangement, and one satisfactory type of floor.

kept at a temperature of 60 to 75° until the stem sprouts are from one half to one inch in length. Sprouted oats should be fed at the rate of one cubic inch per bird per day. Finely chopped cabbage is a satisfactory green feed, and should be fed in open troughs or boxes, so that the entire flock may have access to it. Mangles, sugar beets, rutabagas, turnips, potatoes, carrots or other root crops make suitable green feed when fed raw; these too, should be chopped so that the entire flock may have access to them. Squash, pumpkins, or apples, or anything of like succulent nature are better than no green feed at all. Ensilage can hardly be classed as a green food. Dried alfalfa hay, if properly cured, can be fed profitably to the poultry flock. Though it is not classed as a green feed, lacking succulence, it seems to have a beneficial effect on the flock. It carries vitamines that are healthful particularly when the flock is tightly housed all winter, and it has

been noted by some authorities that when alfalfa is kept before the birds, their disease resistance is increased and much less trouble with common colds is encountered.

The amount of feed that any number of birds require depends largely on the breeding, on the production, and to a certain extent on the temperature. Poultry feeding is largely a common sense proposition, and the amount fed must be varied to suit the birds' appetite. To maintain winter production, it is necessary that the birds hold their body weight. When the flock loses weight, a slump in production is to be expected and when the flock gains weight rapidly, a slump in production usually follows. A safe rule to follow, is to mark three or four heavy producing birds that are laying three to five eggs per week each, catch these birds several times each week, and observe their weight. If they are holding weight and maintaining production, the feeding practice is about right. If they are all losing weight, they should be fed more grain, and if they are gaining weight to such an extent that the abdominal region is becoming hard with internal fat, the grain should be diminished and the birds forced to eat more mash.

Birds that are well bred and well fed may still be unprofitable during the winter months if not properly housed. At this season, new buildings can not be built readily to care for the flocks this winter, but the old buildings can be put into shape to render as satisfactory service as is possible. In constructing new or in remodeling old poultry buildings, it must be remembered that a house must be well lighted, well ventilated, and arranged so that it can be kept clean easily. A building so arranged, regardless of its type or cost, is a satisfactory poultry building.

For new buildings, the Michigan type poultry house is to be recommended under all Michigan conditions. Though it may not be perfect in all respects, it is by far the most satisfactory house for our climatic conditions. In remodeling the poultry house, the first attention should be directed to the windows. These should be on the south side of the building and arranged so that the light is uniformly distributed over the floor space; about one square foot of window space on the south side of the building should be allowed for each ten square feet of floor space. A poultry building that is well ventilated, adds considerably to the health of the birds and to the ease with which they may be cared for. When a well ventilated house is opened in the morning, there will be no marked odor. The walls will be dry, and the litter should not have to be changed because of dampness, oftener than once every three or four weeks. It is possible to install a home-made ventilating system that will work satisfactorily, consisting of a flue outlet or pipe running from a point 12 to 18 inches above the floor, through the roof, and extending on the outside higher than the peak. These flues or pipes can be constructed at home, and should be, if square, at least 14 inches on each side, and, if round, at least 12 inches in diameter; one of these should be in the center of each twenty feet length of poultry house, regardless of its width. This pipe or flue acts as a chimney, the wind or air currents on the outside, blowing across its top, suck the cold, damp, stale air from the floor. The pipe should be capped with a revolving ventilator cap. Air intakes should be provided on the south side of the building, two to each twenty feet length

of building, and each of these intakes should be at least 15x3 inches. The intake pipes should take the air from the outside approximately eighteen inches from the ground level, entering the house below the plate, as shown in accompanying diagram.

Dropping boards should always be provided, and a desirable arrangement is shown in the accompanying diagram.

CURING AND STORING OF SEED CORN

The Effect of Different Temperatures in Drying Seed Corn of Different Stages of Maturity, on Germination

J. R. DUNCAN, AND A. R. MARSTON, FARM CROPS SECTION

Field corn is one of the most important crops of southern Michigan. High yields cannot be obtained unless seed of high vitality is used. In some years, excess precipitation and cool weather occur when field corn should be approaching maturity; these conditions make natural curing and storing extremely hazardous. Artificial methods of curing and storing have been suggested as an aid in saving good seed. To obtain additional information regarding the effect of artificial heat on the viability of the seed the following investigation was undertaken.

Seed was harvested in different stages of maturity, i. e., *milk, †soft dough, and ‡hard dough. A sample of each was placed on a table in the laboratory at an approximate temperature to 68° F. and allowed to dry. After these samples had dried out enough to be shelled and stored without danger of mold due to high moisture content, a germination test was made. All samples germinated 100 per cent. At the same time similar samples were placed in ovens where temperatures could be kept constant and were rapidly dried out so they could be shelled immediately if necessary. It was imperative to have the temperatures rather high to free the corn of its excess moisture. Soft dough and milk samples were left in a temperature of 112° F. for 18 hours while hard dough was left in the same oven at the same temperature for 24 hours. Germination tests of these showed that "soft dough" and "hard dough" samples were not affected by the heating and germinated perfectly, while the "milk" stage was reduced about 60 per cent in germination. When the "milk" stage sample was subjected to a temperature of 95° F. for a period of 36 hours which was twice the time of the former test, the germination was raised about 50 per cent, amounting to 90 per cent.

*Milk (when milk exudes at a slight pressure of the finger nail).

†Soft Dough (when soft dough, which is rubbery in texture, fills the endosperm and kernel begins to dent).

‡Hard Dough (when endosperm is filled with firm dough and the kernel is fully dented).

These tests were made in the laboratory. To test these lots in actual growing conditions, plantings were made in the field. Here the results were brought out more clearly.

The series was planted in triplicate, every fourth row in each series being a check. In this way soil variations were accounted for as each row was compared to its check, which was a standard sample of Duncan seed corn that had been dried by means of natural outdoor air circulation such as would be obtained in any good seed corn drying-house without the use of artificial heat.

One hundred and eighty kernels were planted in each row and the plants counted when they germinated to obtain a record of the germinability of the seed. All plots were handled in a like manner and when harvested each sample of ears was culled. In estimating the yield only marketable ears were considered.

All samples showed a decrease in germinative power under field conditions as compared to laboratory test. Contrasting the germination of the plots which had been kiln dried, to the check plots, (Tables I and II), shows that the germination was lower throughout, indicating that the heating process tended to injure the germination of the seed as well as to drive from it the excess moisture.

Table 1.—Results secured with seed corn kiln dried at 112° F. as compared to air dried sample (Duncan Standard Variety).

Stages of maturity	Time	Germination per cent		Yield (pounds)	
		Sample	Check	Sample	Check
Milk	18 hrs	23	93	25	59
Milk (duplicate)	18 hrs	15	92	15	47
Soft dough	18 hrs	46	92	52	58
Soft dough (duplicate)	18 hrs	83	94	46	53
Hard dough	24 hrs	87	85	49	58
Hard dough (duplicate)	24 hrs	89	85	48	58

The data in Table I shows that in the earlier stages of maturity; i. e., milk and soft dough, heating at 112° F., lowered the germination considerably, but in the hard dough stage the germination did not seem to be affected. The yield of marketable ears seemed to be affected in a like manner and shows a marked correlation to the stage of maturity as affected by that particular drying process.

Table II shows an increase in germination and yield from drying at 95° as compared to that at 112°. Lowering the temperature and increasing the

Table 2.—Results secured with seed corn kiln dried at 95° F. as compared to air dried sample (Duncan Standard Variety).

Stages of maturity	Time	Germination per cent		Yield (pounds)	
		Sample	Check	Sample	Check
Milk	36 hrs	50	85	43	64
Soft dough	36 hrs	65	84	43	73

length of the drying period decreased the harm done by the use of artificial heat.

Table 3.—Table showing results with seed corn which had been air dried in the laboratory at 68° F. as compared to outdoor dried sample (Duncan Standard Variety).

Stages of maturity	Time	Germination per cent		Yield (pounds)	
		Sample	Check	Sample	Check
Milk	Indefinite	92	93	90	59
Milk (duplicate)	Indefinite	88	92	80	47
Soft dough	Indefinite	85	92	69	58
Soft dough (duplicate)	Indefinite	96	94	59	53
Hard dough	Indefinite	87	93	33	47
Hard dough (duplicate)	Indefinite	91	92	40	47

Table III shows the results when corn is harvested in the different stages of maturity and brought into the laboratory where the air is kept at a temperature of approximately 68° F. The corn in the milk and soft dough stages showed equally as good vitality as the check and in this particular case gave a higher yield of marketable ears. This high yield might not hold over a period of years, but this one year's results seem to indicate that when corn is harvested in the early stages of maturity and dried at a slow rate, in a moderate temperature (68° F.), it will retain its germinability and give a yield equally as good as that of out-door dried corn.

Conclusions

1. Seed corn when harvested at any stage of maturity should be stored in a warm, dry place until free from excess moisture and then placed in a cool, dry place.
2. The earlier the stage of maturity and the higher the temperature the greater is the loss in germination.
3. When immature corn is stored in a room the air should be kept at a temperature of approximately 68° F.
4. In drying corn, air should circulate freely so that it may be freed of all excess moisture.

MIXED FEED SERVICE

Recommendation for a Dairy Feed Mixture which can be Prepared by Local Millers or Co-operatives

J. E. BURNETT, DAIRY SECTION

At this season there is an increase in the demand from dairymen in Michigan for mixed grain rations for their herds for the winter feeding months. This demand comes as a result of two factors: first, because most Michigan dairymen in order to utilize efficiently their home-grown grains must add to the ration some high protein feeds; second, because the owners of small herds in which all or a considerable part of the concentrates must be purchased find it frequently more economical to purchase a ready mixed feed than to attempt to buy numerous small lots of feeds at retail prices for home mixing.

These needs for ready mixed dairy feeds are reflected in the sales by elevators, mills and feed stores. Many millers having a local trade are manufacturing and selling a ready mixed feed for local consumption. In most cases the local mixed feed can be sold at a lower price than the feed having a wider distribution because of lower sales cost, lower overhead, and lower freight rates. This results in the establishing of a local market for home grown grains and provides an outlet for some of the by-products of the local mills.

Ready-mixed rations should contain enough digestible protein so that they may be fed unchanged with the poorer grades of roughage, such as timothy hay or even corn stover, and still supply sufficient nutrients for the average cow. The dairyman who has a supply of alfalfa or clover hay does not need to feed a ration containing as much protein as one who is feeding a poorer grade of roughage. Consequently, the former may add home-grown corn or oats to a ration of this kind and thereby reduce the cost of his feed very materially. This is especially advantageous this year when the corn crop in Michigan has been exceptionally good.

The ration outlined here is composed of feeds that are available at most Michigan mills and elevators. It is estimated to contain 22 per cent crude protein, 4 per cent fat, less than 10 per cent fiber, 19.6 per cent digestible crude protein, and 73.5 per cent total digestible nutrients. The cost of the ingredients for this ration will vary somewhat because of freight rates and other local conditions and consequently no estimate of cost is made. It is made up as follows:

500 lbs. corn gluten feed, 23%
300 lbs. ground corn
200 lbs. ground oats
300 lbs. cottonseed meal, 43%
300 lbs. linseed oil meal, 34%
200 lbs. wheat bran
140 lbs. standard wheat middlings
20 lbs. steamed bone meal
20 lbs. calcium carbonate (finely ground limestone)
20 lbs. salt

Suggested Guarantee

Twenty-two per cent protein, 4 per cent fat, less than 10 per cent fiber.

This ration does not contain such feeds as gluten meal, brewer's dried grains, distiller's grains, peanut meal or soybean meal. Though these are excellent feeds for the dairy cow and though it might be possible to make a cheaper or better ration by including some or all of them, the fact that they are rather closely controlled and not always available is sufficient reason for leaving them out of this ration intended for general use by the small dealer.

The dairy cow that has alfalfa hay and silage as a basis for her ration usually does not need much protein in a ration of farm cereals. The cow that is producing about a pound of butter fat a day with such roughage will do very well on a ration containing 12 per cent digestible protein. A cow that has clover hay and silage for roughage should have a ration containing a little over 14 per cent digestible crude protein. Consequently when the cows are getting clover or alfalfa hay, home-grown corn and oats may be utilized with this ration by mixing 1,000 pounds of the ration with the same amount of corn and oats. This will produce a mixture having a little over 14 per cent digestible crude protein.

This would tend to cheapen the cost of the grain ration as both corn and oats are lower in price than the mixture, and it would provide a better ration. Adding protein above the requirements of the cow tends to stimulate milk production but the continued feeding of grains high in protein has undesirable effects on the cow.

The Dairy Department offers a free Feed Service to those millers, dairymen, or others who wish to mix dairy feeds for sale or feeding. Anyone wishing to avail himself of this service should write direct to the Dairy Department, East Lansing, Michigan.

THE GOTHIC ROOF

A Relatively New Type Which is Gaining in Favor in Many Sections

F. E. FOGLE, AGRICULTURAL ENGINEERING SECTION

The type of roof having circular rafters is commonly called a round roof. The name "Gothic" also is used, obviously because of the similarity in appearance to the "Gothic" arch. This term is used so generally that the round roof barn will undoubtedly be known as the Gothic. The terms "Round" and "Gothic" are broadly applied to all roofs having circular rafters coming together to form a ridge.

After considerable investigation, evidence indicates that the Gothic roof originated in Michigan. The use of this type of roof is wide-spread in the state and there are several townships in Isabella county where there is practically no other. As early as 1885, barns were built in Isabella county with rafters of 2-in. x 12-in. plank with the top edges sawed to form a curved roof. This type is illustrated in Fig. 3.

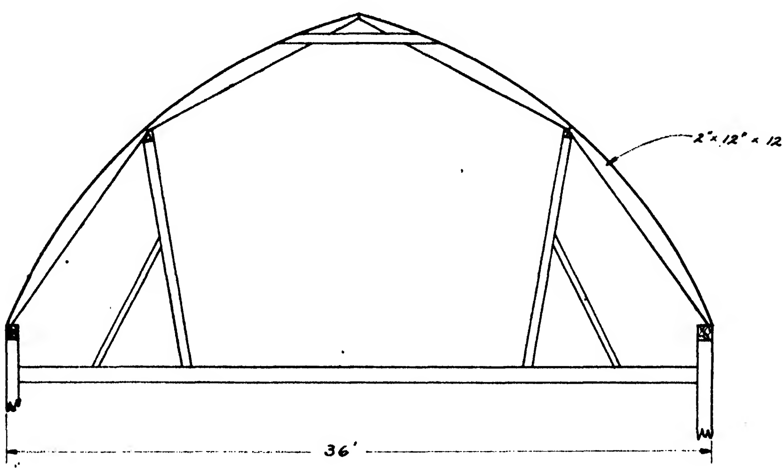


Fig. 3.—An early type of Gothic Roof made of 2"x12" plank.

This was an extravagant use of labor and material for a possible improvement in appearance. Later the rafters were built with a greater curvature using 1-in. x 8-in. or 1-in. x 10-in. boards, three or four feet long, sawed to the proper curvature before being assembled. They were then

nailed together care being taken to break joints. This also was a laborious and extravagant method and soon met with disfavor.

The pleasing—in popular opinion—appearance of the Gothic roof, and the undesirable features of the old styles of its rafters caused builders to experiment with the sprung rafter.

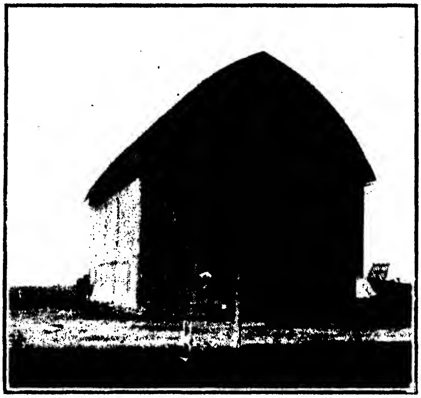


Fig. 4.—A sprung rafter roof on a Shawver Truss Frame, built in 1900. The majority of roofs built at the present time have greater curvature to the rafters.

The sprung rafter was used first,, to our knowledge, in 1892 on a barn located between St. Louis in Gratiot county and Shepherd in Isabella county. It was not widely used until after 1900. When it was found that the sprung rafter was a success and that the same contour could be obtained by bending rather than sawing, the sprung rafter largely superseded the other types.

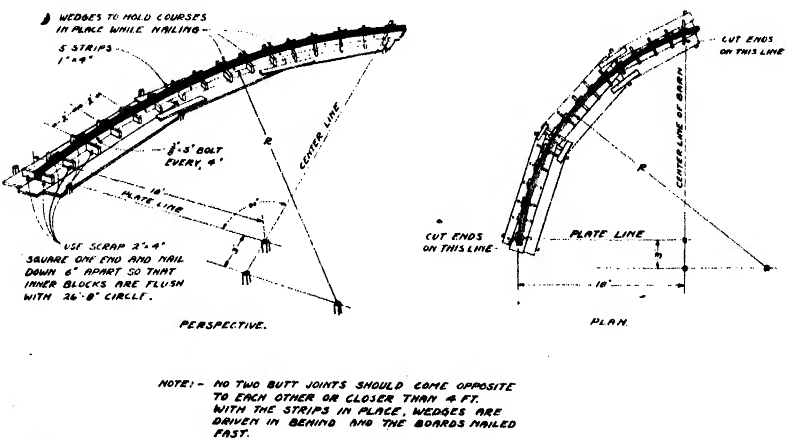


Fig. 5.—Showing a method for laying out and constructing sprung rafters. Any kind of material commonly used in roof construction may be used in their construction.

The barn shown in Fig. 4 was built in 1900. It has sprung rafters on a Shaver Truss frame.

The sprung or bent rafter is commonly made of four- or five-ply of 1-in. x 4-in. strips, brought tightly together in a form, and thoroughly nailed and bolted, with no two joints closer than four feet. The circle of the rafter is

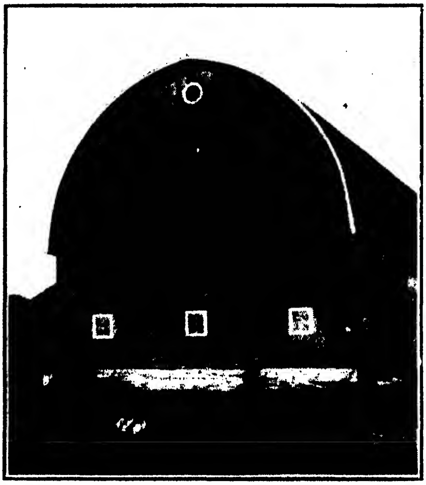


Fig. 6.—A recently constructed barn showing the tendency toward greater curvature. This barn has a timber frame and purlin plates.

first laid out on a level surface and blocks are nailed on the inside and outside of the circle every two feet, leaving space between them so that wedges may be used to bring the several strips of the rafter together. (See Fig. 5.)

The strips forming the rafter should be uniform in width and thickness and as long as practicable. It is important that 12d or 16d nails be used

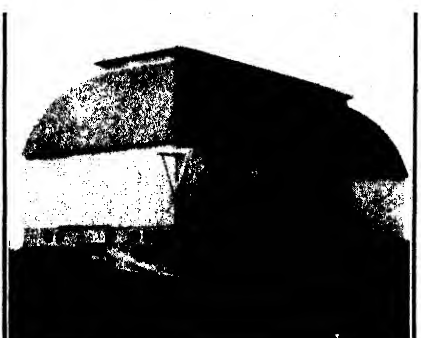


Fig. 7.—A special adaptation of the sprung rafter. This barn is 40 ft. x 80 ft., the deck being 20 ft. x 60 ft. A hay track is installed on each side of the deck.

freely, nailing from both sides of the rafter. It is desirable that 3/8-in. bolts be inserted about every three feet. The rafters are spaced in the roof two feet from center to center. The construction of these rafters is simple and the time required for making them is approximately the same as for making the rafters in a self-supporting gambrel roof.

Carpenters who have had considerable experience with this type of roof state that four men will build the platform and forms in one-half day, and complete the rafters for a 36-ft. x 60-ft. barn in one and one-half to two days.

The curvature to which the rafters are sprung varies greatly. If the rafter is built too straight, the appearance is not as pleasing and haymow space is sacrificed, while if the curvature is too great the roof will be flat at the ridge and very likely to sag. A good practice is to use 2/3 or 3/4 of the width of the barn as the radius of the circle, with the center located about 3 feet below the top of the plate. A few roofs have been noted in which the top 5 feet or 6 feet of the rafters was left straight. This is a pre-

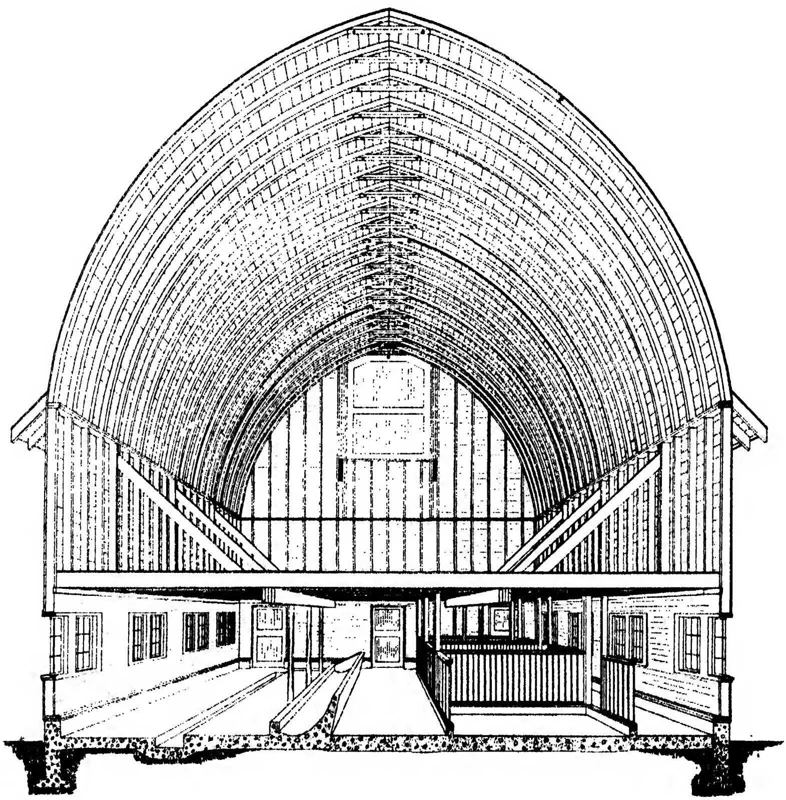


Fig. 8.—An interior perspective of a self-supporting Gothic roof having laminated rafters on a wing joist frame. A 4"x4" collar joist about 4-ft. long bolted to the rafter at each end tends to prevent sagging at the ridge.

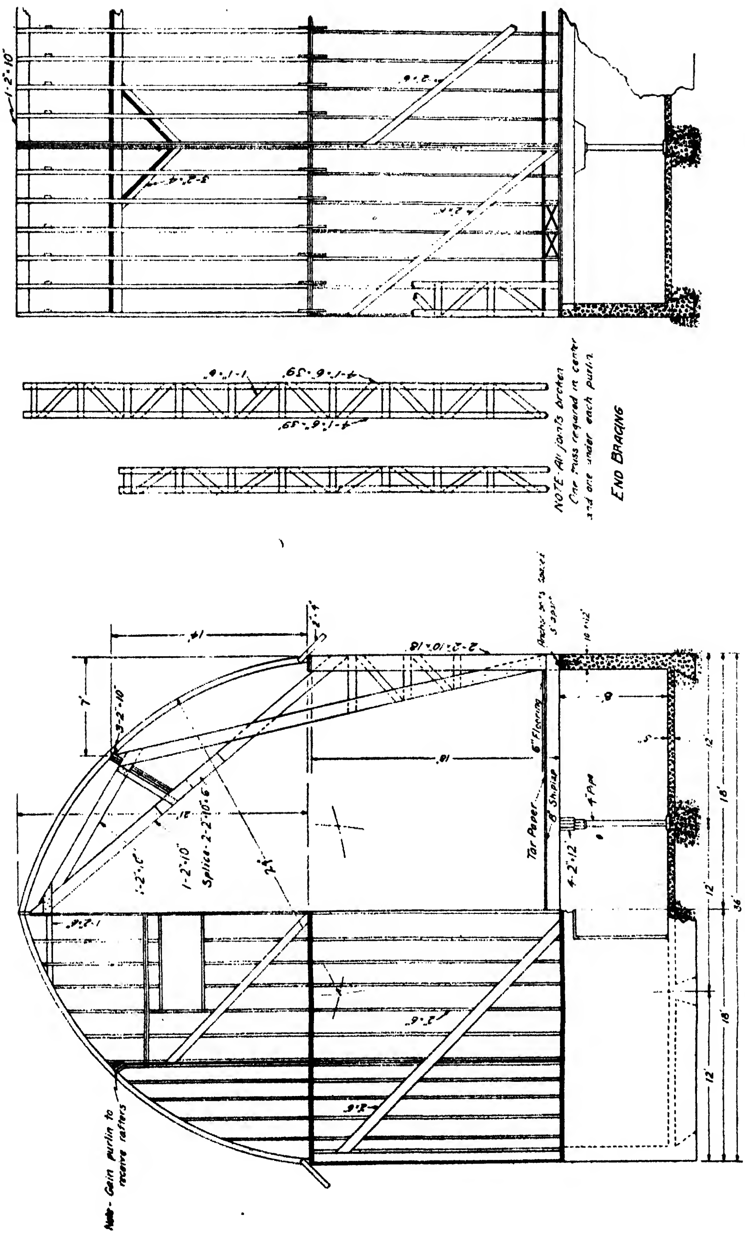


Fig. 9.—Framing details of a Gothic roof on a Shawver Truss.

caution against the roof sagging and becoming flat at the ridge and, in the opinion of many, improves the appearance.

Some builders leave the two top plies of the rafters to project over the plate and form the eaves. When this is done the two top plies should be sprung out to throw the water farther from the building and to improve the appearance. This method furthermore, makes it possible to nail the rafters more securely to the plates.

The Gothic roof may be used as a self-supporting roof, as shown in Fig. 8. It seems to be strong enough on barns not wider than 36 feet. The few failures that have been noted were due to gross error in designing or in construction. The fact that the sprung rafter can be used as a self-supporting roof makes it particularly desirable for use in remodeling timber frame barns. The old roof may be removed, the plates straightened and the Gothic roof put on.

The sprung rafter Gothic roof is well suited also to use on Shawver Truss framing. On this frame it is very rigid and since the rafters are made fast near their middle the roof is less likely to become uneven than the self-supporting roof. (See Fig. 9.) The sprung roof invariably shows some unevenness on its surface. This does not necessarily indicate a weakness if the design and construction is correct.

RYE FOR FATTENING HOGS

W. E. J. EDWARDS AND G. A. BROWN, ANIMAL HUSBANDRY SECTION

Large quantities of rye are grown and fed to hogs in this state. The most advantageous utilization of this grain is therefore of considerable importance to a large number of hog feeders. This paper reports a continuation of investigations conducted by this Station to ascertain the most efficient method of feeding rye to growing and fattening pigs.

This experiment was started November 23, 1924, when the pigs used averaged approximately 125 pounds each in weight and it terminated for the different lots between January 30 and February 10, 1925, when the average weight of the pigs in each lot was approximately 225 pounds.

Fleischmann's pure dry yeast for livestock was used. It was purchased in 2½ pound tins. Sixty per cent tankage was fed to each lot throughout the feeding period. The rye and oats fed were finely ground in all cases. The mineral mixture used was composed of: acid phosphate, 30 lbs.; finely ground limestone, 30 lbs.; common salt, 30 lbs.; sulphur, 5 lbs. The trough fed lots were fed twice daily and were given as much at each feeding as they would clean up in a reasonable time.

The pigs were distributed to the different groups as equally as possible, in regard to weight, age, breed, sex, type, condition, health, thriftiness and previous treatment.

They were housed in the college piggery. Each group had access in addition to a small outside lot when the weather was suitable.

TABLE 1.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
	Gr. rye, gr. oats, tankage, mineral. Mixed soaked, trough fed.	Gr. rye, gr. oats, tankage, mineral. Mixed trough fed.	Gr. rye, gr. oats, tankage, yeast, mineral. Mixed, fermented, trough fed.	Gr. rye, gr. oats, tankage, mineral. Mixed, self-fed.	Gr. rye, tankage, mineral. Mixed self-fed.
No. of hogs per lot	6	6	6	6	6
Av. initial weight	126.33	127.33	124.16	127.66	127.16
Av. final weight	225.33	225.50	225.00	224.83	225.33
Av. gain per hog	99.00	98.17	100.84	97.17	98.17
Av. daily gain	1.356	1.309	1.483	1.230	1.363
Days to reach 225 lbs	73	75	68	79	72
Av. feed comsumed daily:					
Ground rye	4.261	4.115	4.340	4.006	6.576
Ground oats	2.181	2.058	2.170	2.003	....
Tankage	.190	.179	.190	.173	.260
Yeast	....	....	.117	....	....
Mineral	.067	.063	.067	.062	.068
Total	6.799	6.415	6.784	6.244	6.904
Feed required for 100 lbs. gain:					
Ground rye	321.57	314.41	292.67	325.68	482.32
Ground oats	160.78	157.21	146.33	162.84	....
Tankage	14.04	13.68	12.87	14.08	19.10
Yeast	....	....	1.13	....	....
Mineral	4 96	4.85	4 52	5.03	5 01
Total	501.35	490.15	457.52	507.63	506.43
Feed cost per 100 lbs. gain at following prices: Rye $0.98 per bu. Oats $0 56 per bu. Other feeds at prices given below	$8.91	$8.71	$9.02	$9.02	$9.06
Value received per 100 lbs. of rye and oats considering: Tankage at $60 per ton, mineral at 1c per lb., yeast 80c per lb:					
Hogs at $8 per 100 lbs	$1.56	$1.60	$1 52	$1.56	$1.53
Hogs at $10 per 100 lbs	1 98	2.02	1.97	1.97	1.94
Hogs at $12 per 100 lbs	2 39	2 45	2.43	2.38	2.36

In determining the feeding value of the rye and oats as given in Table I no consideration was given to the labor involved or the overhead expenses such as use of equipment and interest on money invested. On the other hand, the value of the manure was not credited.

Feeds Used and Methods of Feeding

Lot 1, for the first 30 days, received a mixture of: ground rye, 100 lbs.; ground oats, 50 lbs.; tankage, 5 lbs.; minerals, 1.55 lbs. During the remainder of the period they were given: ground rye, 100 lbs.; ground oats, 50 lbs.; tankage, 4 lbs.; minerals, 1.54 lbs. This mixture was soaked 24 hours before feeding.

Lot 2 was fed the same mixture as lot 1, but the various feeds were mixed in a slop just before feeding.

Lot 3 received the same feeds as lot 1, with the addition of ¼ lb. yeast to each 100 lbs. of the mixture. This compound was allowed to ferment 24 hours before feeding.

Lot 4 was fed the same ration as lot 1. This was mixed and fed in a self-feeder.

Lot 5, during the first thirty days, was given a mixture of: ground rye, 100 lbs; tankage, 4.8 lbs.; minerals, 1.05 lbs. For the remainder of the period it received: ground rye, 100 lbs.: tankage, 3.5 lbs.; minerals, 1.03 lbs. These were mixed and fed in a self-feeder.

Lots 4 and 5 which were self-fed had access to water in an automatic waterer at all times.

Lots 1, 2 and 3 were trough fed. An effort was made to add to the mixture given these lots an amount of water adequate to meet their requirements.

Summary

1. The addition of one-third ground oats to a self-fed ration of ground rye, tankage and minerals did not prove advantageous. The latter ration produced somewhat larger daily gains with a trifle lower feed requirement. This was unexpected, as it had been thought that the addition of oats would show an improvement.
2. While the rye, oats, tankage and mineral mixture that was fermented with yeast made somewhat more favorable gains than did a similar mixture minus the yeast, this advantage did not cover the cost of the yeast, to say nothing of the added labor in preparing and feeding the yeast fermented ration.
3. Soaking the rye, oats, tankage and mineral mixture produced practically the same daily gains, but required slightly more feed for 100 pounds gain than did a similar mixture mixed in a slop just before feeding.
4. The self-fed mixture of rye, oats, tankage and minerals made smaller daily gains and required somewhat more feed for 100 pounds of gain than did trough feeding a similar ration. Self-feeding, however, usually compares favorably with trough feeding for finishing pigs of this weight.
5. This experiment as well as others conducted by this Station and by Experiment Stations in other States show favorable results with rye as the major portion of the ration for growing and fattening pigs. On the other hand, certain other investigations conducted here and by other stations have given less favorable results, especially when heavy rye feeding was practiced over a longer period than two or three months.

THE COLLEGE FOREST NURSERY

Many Thousands of Trees are Distributed Each Year to Assist Landowners in Forest Planting

A. K. CHITTENDEN, FORESTRY SECTION

For many years the Forestry Department of the Michigan State College has been furnishing to residents of the state, trees at cost of raising them for forest and windbreak planting. For this purpose it maintains a forest tree nursery on the College farm. The nursery covers 27 acres and contains, in addition to the seed beds and transplant rows, numerous experimental plots and plantings of foreign trees which are not for sale. No trees for strictly ornamental planting, or individual or specimen trees, are sold.

Sales are limited to seedlings and small transplants suitable for forest plantations, and these only in lots of 100 or more. They are confined to a few species, such as pine, spruce, black walnut, chestnut and European larch. The college does not enter the commercial nursery field.

Since 1909 the number of trees shipped from the nursery, by years, has been as follows:

Year	Trees	Year	Trees
1909	292,486	1918	46,732
1910	361,150	1919	261,860
1911	320,935	1920	110,234
1912	111,354	1921	93,844
1913	102,883	1922	106,350
1914	321,991	1923	155,251
1915	332,000	1924	203,198
1916	145,281	1925	258,734
1917	98,007		
		Total	3,322,290

The majority of the trees raised in the nursery are evergreens, particularly pine and spruce. These species will grow on poorer soils than most of the hardwoods and produce larger yields of timber in a shorter time.

The Forestry Section is also starting a forest nursery at the Dunbar forest experiment station and farm near Sault Ste. Marie. Here it will raise trees for distribution in the Upper Peninsula. The nursery was started last spring and the first trees will be ready for shipping in 1927.

The object of these nurseries is to assist landowners in forest planting. Forest plantations are a long-time investment and, in order that they may be profitable, it is necessary that the initial outlay be as small as possible since money increases rapidly when figured at compound interest. For this reason, rather small trees are used, as the cost of the stock and of planting is less and there is less danger of transplanting loss than with larger trees.

For forest planting on a large scale, seedling stock is recommended. For planting on a small scale, small-sized transplants are suitable. The younger the stock the longer it will be before it reaches maturity, but where the trees are raised for forests or timber supply a few years more or less is of little matter.

For forest plantations a planting distance of six by six feet is usually recommended. This spacing requires 1,210 trees per acre. A spacing of six by eight feet is sometimes used, requiring 825 trees per acre. The advantage of the closer spacing is that the trees will close up sooner, shading the ground and thus preventing the growth of grass and weeds. Crowding will also cause them to grow straight and tall with few side branches. With a wider spacing it may be necessary to prune the trees by hand but this may be compensated by the smaller number of trees required to establish the plantation and the consequent reduction in initial cost.

White pine and Norway spruce are the two trees most extensively planted on private lands for forest plantations. Both of these grow rapidly, do well on rather poor soil, and their product is valuable. White pine requires 40 years to produce saw logs. The Norway spruce is valuable for pulpwood, but it usually is cut when about 10 years old for Christmas trees. Mixed plantations of white pine and Norway spruce are sometimes established, the Norway spruce being cut for Christmas trees after a few years and the white pine left for timber production. In the same way, Norway spruce may be planted in mixture with black walnut or any other species where the soil is suitable for both.

For fence post plantations, chestnut and European larch are probably the best trees to use as they grow fairly rapidly and make very desirable posts. They require about 18 years to produce fence posts.

Forest plantations have a commercial value long before the trees reach usable size. This value is based upon their prospective value for timber and increases as the trees become larger.

Forest plantations may be established advantageously in order to utilize idle lands or poor soil not needed for farming. A forest plantation requires but a small outlay and needs little attention once it is established.

JACK PINE AT EAST LANSING

Shows Fairly Rapid Growth on Good Soil

P. A. HERBERT, FORESTRY SECTION

A small plantation of Jack pine (*Pinus banksiana*) was established at East Lansing, Michigan, in an effort to determine its growth under good conditions of soil and moisture.

The seed from which the stock for this plantation was secured was sown in the College nursery in the spring of 1904, and set in transplant rows in the spring of 1906. There is no record as to the origin of the seed. The stock was planted on the site it now occupies in the spring of 1907. The soil is a coarse sandy loam that had been cropped previous to the planting of these trees, and is heavier and moister than that usually occupied by Jack pine. The spacing was 4 by 4 feet.

During the first few years the plantation was cultivated. The trees grew so fast, however, that this was soon impracticable. In the spring of 1919 hemlock and Norway spruce were planted under the Jack pine. Not a single specimen of these trees remains today. The extreme density of the Jack pine stand doubtless made growth impossible for these small trees. Hemlock is very tolerant of shade and could not have been killed out by shading, but might have been affected by the absorption of most of the summer soil moisture by the deeper and better rooted Jack pines.

In the fall of 1920 a thinning was made on a portion of the plot. This thinning removed not only the dead and dying trees, but also all those that received no direct sunlight and some of those that still received a little light from directly overhead. Inferior, crooked, defective and overcrowded trees were cut in order to allow the best formed and developed trees to continue their growth without crowding from inferior trees. Approximately 34 per cent by volume was said to have been removed.

A very severe ice storm the following spring broke off a number of trees that had been released by the thinning. Trees in a dense stand have a very restricted root system which is capable of holding them upright only while they are protected by neighboring trees. When such trees are suddenly freed and subjected to more wind or ice than they are accustomed to, serious windfall may result. The best time to make thinnings, where wind—or snowbreak is feared, is in the spring after the danger from storms is over but before growth starts. This gives the remaining trees an entire growing season to accustom themselves to the changed conditions before they must again face adverse weather.

In the fall of 1923 a small permanent sample plot was established,

a portion of it being located in that part of the plantation that had not been thinned. A careful study was made of the growth and development of the trees on this plot. On the unthinned portion all the original trees are still standing, although several of them are dead. Here the crown density is 8.1. (A density of 10 denotes that the crowns of the trees blend into one another, allowing no direct sunlight to filter through.) In the thinned stand the crown density is only 7.3, but the trees are rapidly closing the openings made in the crown canopy by the thinning.

The crowns of trees are segregated into classes depending upon the amount of direct sunlight that they receive. For example, a tree that is exceptionally tall and receives light not only from above but also from the side, is classed as dominant. Trees that receive plenty of light from above but little from the side are classed as co-dominant; these are the average trees in the stand, making up the general crown level below the tops of the dominant trees. Intermediate trees are those that are slowly being crowded out; the crowns are small and they receive only a little direct sunlight from above. Overtopped trees do not receive any direct sunlight, their crowns being under the crowns of the bigger trees. If these trees are still relatively thrifty they are classed as oppressed, but when they are dying or dead they are called suppressed.

All the crowns in the stand mentioned were carefully plotted, measured and classified. In the unthinned portion the trees classify as follows: dominant 15 per cent, co-dominant 50 per cent, intermediate 21 per cent, oppressed 5 per cent, and suppressed 9 per cent. In this stand, then, 35 per cent of the trees are inferior and only 15 per cent are above the average. In the thinned plot the trees classify quite differently: dominant 30 per cent, co-dominant 56 per cent, intermediate 10 per cent, oppressed 1 per cent, and suppressed 3 per cent. Judicious thinning has increased the percentage of superior and decreased the number of inferior trees. The trees on the thinned plot are larger and in all respects better than those on the unthinned plot.

A study of the crown areas showed many interesting correlations. The crown area of the average dominant tree is 22.48 sq. ft.; the co-dominant trees average only 14.88 sq. ft.; the intermediate trees, 8.64 sq. ft., the oppressed trees 5.6 sq. ft. and the suppressed 4.8 sq. ft. The relation between crown area and diameter or crown length or total height is very evident. It was found that if the crown area was known the approximate diameter, height, and crown length could be determined. The crown area of the trees by diameter classes is as follows: For the one-inch class 7 sq. ft., for the two-inch class 10 sq. ft., for the three-inch class, 17 sq. ft., and for the four inch class 23 sq. ft. The crown area is indicative of the wood-producing capacity of the tree as the materials from which the cellulose composing the wood substance is manufactured are formed in the crown.

Even though this stand has been comparatively dense the trees have not developed clean straight boles, but have the characteristic crooked stem of the Jack pine as found on the sand plains of northern Michigan. However, the growth has been more than expected, the mean annual increment being 90 cubic feet per acre. During the last five years the periodic annual increment has been approximately 6 per cent. The

average height is 25 feet and the average diameter breast high, i. e. 4.5 feet above the ground, is 2.8 inches. In the last few years the trees in some portions of the plot have decreased materially in growth because of excessive competition, and further thinnings will be necessary to prevent stagnation.

A careful record of future treatment will be kept, and the entire plot remeasured every five years to determine the effect of such treatment. As each tree is numbered it will be possible to follow the development of individual trees.

PREVENTION OF CROP INJURY BY WINDSTORMS ON MUCK LAND

A Discussion of the Use of Water, Heavy Rolling and Windbreaks in the Prevention of Crop Destruction by Winds on Muck Land

PAUL M. HARMER, SOILS SECTION

The spring of 1925 was one of the most disastrous that has ever been experienced by the muck farmers of the state. The beginning was very favorable, permitting early planting, but the month of May was one of the driest, as well as the windiest, on record. With the surface of the muck very dry, frost, which occurred during the latter part of May, produced a much greater injury to the muck crops than would have been the case with normal rainfall. Mint was frozen to the ground; early cabbage, beets and celery were killed, and onion fields on the drier mucks seriously injured.

Crops were replanted and conditions looked better, when, on June 9, the greater part of Michigan, together with northern Indiana, Ohio and Illinois, was visited by a severe windstorm. This started shortly after 10 A. M. at Lansing and lasted the remainder of the day. Muck fields which were bearing cultivated crops were left as barren as if they had never been planted, and in some places even grain were carried away. Crops, weeds, fertilizer, and muck to a depth of three or four inches were swept to the nearest meadow, grain field, windbreak or ditch. In addition, some parts of the state were visited by a less severe windstorm on June 22, which undid some of the repair work done following the storm of June 9.

The extent of the windstorm of June 9 is evident from the fact that eight out of eleven of our experimental projects on onions were blown out, those in Huron, Gratiot, Newaygo, Barry, Lenawee, Eaton and Clinton counties being destroyed. Of the three sets that withstood the storm, one was protected on the west by a good growth of sweet clover, one was a very sandy muck and the third was saved by the thoughtfulness of the farmer, who piled onion crates along the west side of the plots to protect the crop.

During periods of normal rainfall, injury to a muck crop is generally due to cuts and bruises inflicted on the plant by the blowing particles. Dur-

ing the windstorm of June 9, however, an even greater injury was produced by the removal of several inches of the dry muck. Onions were left hanging by the ends of their roots and their destruction was completed when the warm sun of the following day dried the roots. Mint roots were either blown from the field or left lying exposed on the surface, where the winds soon dried them beyond recovery. Following the windstorm of June 22, the writer observed seed of late potatoes, which had been planted with a hand-planter, lying exposed on the surface of the muck, showing the removal of at least two inches of the surface soil.

Because of this severe wind injury to the crops during the past spring, farmers are now inquiring about the chances of a repetition of the occurrence. Mr. D. A. Seeley of the U. S. Weather Bureau at East Lansing, reports that the combined rainfall of May and June in the vicinity of Lansing was less during the present year than for the same two months of any year since 1864. He reports also that there is no record for the state showing a similar combination of drought and high winds, so conducive to crop destruction, as occurred during the past spring. Muck farmers of Huron county report an even more destructive wind, which completely destroyed their onion plantings, in 1901. Though there seems to be little chance of such recurrences in the near future, "muck storms," on many of our drier muck areas, often occur several times in a season. Furthermore, on all muck land the destruction by wind storms of many of the specialized crops and the removal of the top soil, even occasionally, is cause for consideration, and means of prevention of such possible loss is a good form of insurance.

Damage by wind to crops on muck land may be greatly lessened by three different means, viz.:

1. Maintenance of a good supply of moisture in soil.
2. Compaction of soil by heavy rolling.
3. Use of windbreaks.

The use of any one of these methods alone is often not sufficient. In fact, it is advisable, in a good system of muck farming, to employ all three methods.

Control of the Moisture Supply

Maintenance of a good supply of moisture in a muck soil is necessary primarily for securing a good stand and good growth of the crop planted but its effect in preventing blowing of the muck is important. The moisture supply may be increased during a drought either by sub-irrigation or by overhead irrigation. The overhead system of irrigation gives very good results because when the surface of the muck is wet, it is not blown by wind. Because of the expense in installing this system, its use must be limited to the more intensive truck crops, such as celery. Growers of this crop with this means of supplying moisture were very fortunate during the past spring, both in the protection of their seed beds and in the setting of their celery in the field. It is obvious that, along with the overhead irrigation it is necessary to have windbreaks to prevent injury from muck blown from neighboring fields.

Sub-irrigation for maintaining a supply of moisture in time of drought is better adapted to general farming and to mint and onion growing. It

consists in the damming of the drainage ditches (1) or closing of tile, to back up the water and raise the water level in the soil. Its success depends entirely on a constant supply of water in the ditches in time of drought. If the muck is excessively drained, a dam, or system of dams, in the outlet ditch will be required. In some localities water can be secured by the diversion of a creek, while in others it is possible to secure artesian wells which open into the ditches just above the dams.

Use of Heavy Roller

Heavy rolling of muck land compacts the soil and thus induces a better capillary movement of water. As a result the surface layer dries out less, and consequently does not blow as badly. Reports made by several farmers who are using concrete rollers (2) which weigh 600 pounds or more per foot of length, showed in all cases during the past spring less blowing of the rolled muck than of that not rolled. Heavy rolling is especially beneficial when used in connection with the sub-irrigation, unless the muck is exceptionally heavy. Following heavy rolling, cultivation should be shallow.

Use of Windbreaks

The different types of windbreaks may be listed as follows:

1. Trees
2. Board fences
3. Cheese cloth covering
4. Shrubbery
5. General crops

Windbreaks composed of trees have been by far the most important factor in reducing loss of crops during the past spring. On many muck farms, the only early crops remaining were those protected by mixed groves of ash, elm, maple, white cedar, tamarack or other trees, located on adjacent land which had not yet been cleared. On some farms, rows of trees planted along the line fences have proven very beneficial, Norway spruce, white cedar (arbor vitae), box elder, willow and Carolina poplar being most common. The last of these is a large tree but is said to be short-lived. A good windbreak can be secured with a combination of one row each of golden willow or box elder and of Norway spruce or arbor vitae. The golden willow and box elder are rapidly growing trees and in a short time give considerable protection, while the Norway spruce and arbor vitae, being long-lived evergreens, make an efficient windbreak in later years. Of the two, the spruce appears to make more rapid growth on muck land but the arbor vitae produces a denser windbreak.

There are two objections to the use of trees for windbreaks on muck land: first, the loss of considerable areas which might be utilized for crop production, and second, the time required for tree growth. On the larger muck

(1) For information regarding the construction of a cheap type of dam for the larger drainage ditches see: May, 1925 issue of the Michigan Experiment Station Quarterly which may be secured by addressing R. S. Shaw, Director, East Lansing.

(2) For information regarding the construction of a concrete roller see: May, 1924 issue of the Michigan Experiment Station Quarterly which may be secured by addressing R. S. Shaw, Director, East Lansing.

farms, the first criticism is not important and the second unavoidable. On the small intensively farmed muck areas, however, both points are important. Here the solid board fence solves the problem. On small fields the height of this fence need not be more than three to five feet, and it should cover at least the side (usually west) of the field from which most of the windstorms come. By this means, injury from the muck brought from neighboring fields is avoided, and by other means damage from removal of muck within the field can be prevented.

The use of some cover, such as cheesecloth, for the protection of a muck crop from wind injury, is out of the question because of the expense, except in the case of celery seedbeds. Many of the smaller growers have adopted the practice of surrounding the celery seed bed with a board fence, approximately one foot high, from side to side of which is suspended a cheese cloth sheet. Often this is fastened to a rod at one end so that the sheet can be rolled up in favorable weather. This protection is provided chiefly to prevent frost injury but has been found beneficial in muck storms.

Of the different shrubs used as windbreaks, two should be mentioned. New York muck farmers report the use of the black currant, and the Japanese (sometimes called California) privet, as efficient windbreaks. These are planted in rows at intervals across the field. Another crop which has proven fairly satisfactory on the more acid muck areas is the raspberry. With the exception of the privet, these shrubs have the advantage that, besides serving as a windbreak, they produce crops as well.

Three types of general crops have proven useful as windbreaks: hay, corn and grain. Of the hay crops, white blossomed biennial sweet clover should be placed first and alfalfa second. The place for these crops is along the ditch bank where their rapid growth in spring serves to smother weed growth and to prevent injury to crops for some distance in ordinary windstorms. On onion plots near East Lansing, sweet clover on the west prevented injury to the first 15 rows, with little injury to the next five rows, of onions, even from the violent windstorm of June 9. Alfalfa is not satisfactory for this purpose unless the muck is well drained.

Corn has been used as a windbreak in some of the smaller muck fields. The crop is planted in single rows at intervals across the field, the ears harvested in the fall and the stalks allowed to stand during the following summer.

Of the grain crops, rye is best suited to use as a windbreak. It has been found especially satisfactory for use with the onion crop. The field must be staked out in the fall and the rye sown fairly early so that it will make a rapid growth in the spring. Sowing can be done with an ordinary garden seeder, the distance between rows depending on the sweep of the wind across the field. Rows should extend at right angles to the direction of the wind. One onion farmer recommends planting rye instead of every twentieth row of onions. This is probably close enough, except in places where wind injury is an almost annual occurrence. In some places strips of three to six drill rows of rye may be required. Another muck farmer reports successful use of rye for the protection of new mint. On a portion of his field which blew badly, he sowed rye in the fall in rows the same distance apart that the mint was to be planted. In the spring the mint was planted between the rows of rye. In the case of both onions and mint, the rye should be cut before it has reached maturity in order to prevent a volunteer seeding the following year.

CONTROL OF OUTPUT IN AGRICULTURE

C. F. CLAYTON, ECONOMICS SECTION

Controlling output is obviously a business problem, but it is not a problem with which the farmer can deal just as the business man does. Moreover, the problem of controlling output should not be confused with organized efforts to restrict output for the purpose of establishing a monopoly element in price. The confusion of the idea of "restriction of output" with "control of production" is perhaps due in part to the over-emphasis of the false analogy between agriculture and "business." Restriction of output for monopoly advantage would not be desirable in agriculture, even if it were possible. It is equally undesirable in business, of course. Control of production looks to the most economical utilization of our economic resources, and hence is socially, as well as individually, desirable.

The business man can exercise a rather effective control over output. The farmer cannot. The distinction here does not rest upon the degree of monopoly in the two industries. When the farmer's crop is planted he has committed himself for a year or longer. The business man can alter his production program on much shorter notice. The farmer's program is subject to the influence of climate, rainfall, pests, etc., to a degree unknown to the business man. Orchards and vineyards, moreover, require several years to come into production. Increase or decrease of output is a slow process. Even livestock producers are subject to cyclical changes in prices to which it is difficult to make adjustments.

The very idea of competition implies that producers (or sellers) shall act with a view to the conditions of the market, i. e., that they shall be in possession of information which affords them a rational basis for action. It is when these conditions are not fulfilled that maladjustments occur. Control of production aims at the elimination of these maladjustments, that is to say, at the establishment of the conditions of genuine competition among producers.

What opportunities are open to farmers' business organizations to effect control of production? The condition established by the nature of farming is that control must be effected through influence exerted on the individual farmer. The large business unit is not adapted to farming.

In addressing themselves to this problem of controlling output, farmers' business organizations have employed three main methods:

(a) Restriction of acreage by agreement
(b) "Signing up" the entire acreage
(c) Supplying information as to supply and demand conditions.

The first method addresses itself directly to cutting down output by collusion among producers. This method has been amply validated by its employment in the business world. No marked success has attended efforts to apply it in agriculture. On the contrary, little but trouble and disappointment has resulted therefrom. The reason for its failure may be briefly assigned to the fact that a given producer is benefited by increasing his acreage,

if it is agreed that all others are to reduce acreages. With that the matter may be dismissed. However, one dislikes to rest the explanation of an economic fact on the proposition that an individual's interests are served in the long run by a betrayal of his fellows. In point of fact, there is no basis for a general agreement among a large number of farmers to restrict acreage at a particular level of prices. The interest of the sub-marginal farmer would doubtless be served by a restriction of acreage. But a similar action on the part of the intra-marginal farmer would be trebly condemned; it would (a) reduce his total profits by curtailing his output and (b) encourage a high cost farmer who was responsible for the depression to continue producing and (c) make room for a still higher cost producer to come in on the margin. There are, therefore, economic considerations which work against the success of such a plan, independent of any consideration of "betrayal."

Restriction of output in industry, be it noted, is found to be economical, chiefly because the less efficient plants are shut down and the product is turned out at a lower unit cost. Restriction of acreage by agreement favors the inefficient and penalizes the efficient farmer.

Signing up the entire acreage does not point directly at restricting output. The direct object is to reduce the overhead cost of marketing by securing a larger volume and to give increased bargaining power to the marketing organization. But if favorable prices later stimulate other (non-member) producers to enter the market, the employment of methods analagous to the boycott in keeping this output from reaching the market is not unknown in the history of farmers' business organizations.

This method of controlling output aims to cut off from the market those producers who are responsible for the increase in output. By definition, these producers are those who are not members of the organized group supplying the market. However, it may be argued that responsibility for the increased supply rests with the organized producers. The supply price evidently is high enough to bring formerly sub-marginal producers to the market. The obvious remedy is a lowering of the supply price to a point which eliminates the undesirable competition. Control of supply by price adjustment obviously is open only to organizations which market a product having a relatively restricted producing or marketing area. Such organizations may find themselves, therefore, in a rather delicate position, due to the fact that the long-run interests of the industry may not be served by taking the highest price which the market affords at a particular time. Nevertheless it is precisely the function of getting the highest price that the market affords that many farmers have imputed to their business organizations. Indeed, some farmers appear to expect their co-operative organizations to get a higher price than the market affords. There is undoubtedly room for a consideration of the proposition that such real bargaining power as farmers' business organizations possess may find its chief application in the rational control of production, rather than in its employment for securing short-run price advantage from temporary conditions of the market. The weakness of this method rests in the limited range of its applicability and in the severe strain it places on the moral courage of the organization and its members. Needless to say, it calls for an abandonment of the idea that the chief service of a co-operative business organization is as a bargaining agency.

Furnishing information as to conditions of demand and supply offers a

third means of reaching the individual farmer. Central co-operative marketing organizations have channels for distributing such information through their local units. Central organizations are also in a fairly good position for collecting such information. Rather effective service of this kind is now rendered by central organizations, but the information is confined chiefly to current supply and demand conditions. It is a marketing service. Very little effort is made to collect basic data which might serve to guide the farmer in his production program. Perhaps this is well. We say this, not because we think the problem is one which farmers' business organizations can ignore. Quite the contrary. It is not clear however, that this is a service which farmers' marketing organizations are now in a position to render. Undigested data would be of no use to the farmer. Properly to handle such data requires the services of a trained technical staff. Moreover, it is not yet clear to the present writer that such information coming from a central organization to individual farmers would be effective. Such information should probably be presented to groups of farmers at appropriate times, where it can become the subject of discussion among them. The agency for collecting and presenting the information should be a feature of the buisness organization of farmers, supported by them and responsible to them.

One further aspect of this question of controlling production may be mentioned. This relates to the development of stable systems of farming as a means of avoiding the necessity of shifts in production. The desirability of promoting the establishment of systems of farming in well defined areas may be admitted without prejudice to the question of the effectiveness of this as a method of solving the problem of adjustments in production. It may be urged that problems of adjustment will still confront the individual producer, because of shifts in relative costs of the factors he employs, regardless of the question of changes in the relative price of his product. But until the industry has reached a much more stable condition than characterizes it at present adjustments in the agricultural industry as a whole must occupy a prominent place in the program of producers who are in marginal areas and are on the margin of production. But in so far as established systems of farming may cause farmers to look for their profits from adjustments which bring the best returns over a period of years, rather than from hasty and ill-advised shifts in response to temporary price movements, such semi-permanent programs will have a good effect. Nevertheless, far from being a solution of the problem, the very inception of such a program calls in question the whole technique of adjustment. The operation of economic forces has already worked out certain broad areas devoted to rather well defined systems of farming. To what extent can a program for established systems of farming go beyond this? It cannot go very far, certainly, until a more detailed economic analysis lays the foundation (a) for a more effective adjustment of the proportions of the factors among producers within the established area and (b) for a rational adjustment of producers in marginal areas or on the margin of production to the opportunities of the market.

So far as control of output is concerned, therefore, it is clear that the problems of the farmer are chiefly remarkable for the extent to which they differ from those of the business men. For this reason, analogies drawn from the methods of "business" are likely to give little help to the farmer, and may do much harm.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, East Lansing, Michigan.

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262 Suggestions on Planting an Orchard.
264 Second Report of Grade Dairy Herd.
267 Michigan Weeds (only to libraries and teachers).
273 Utilization of Muck Lands.
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281 Trees, Shrubs and Plants for Farm and Home Planting.
284 Some Information and Suggestions Concerning the Use of Phosphorus.
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67 Investigations on the Blackleg Disease of Potato.

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MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN
Vol. 8, No. 3, February, 1926

PASTURE FOR PIGS

Alfalfa and Rape Prove very Satisfactory for Growing and Fattening Pigs

W. E. J. EDWARDS, G. A. BROWN, AND G. A. BRANAMAN, ANIMAL HUSBANDRY SECTION

Forage crops play a very prominent part in the growing and fattening of the spring pig crop on nearly all successful swine breeding farms. Though bluegrass provides good pasture during the spring and fall, it dries up badly and is of little value during the dry summer months. Alfalfa and rape supply an abundant growth of palatable, succulent and nutritious forage throughout the season and for this reason are used extensively, especially alfalfa, in producing both market and breeding hogs. In order to throw more light on the feeding value of these crops when used with different concentrates, for growing and fattening spring pigs, a series of experiments have been conducted by the Michigan Experiment Station. Part of the 1924 and 1925 work conducted by this Station is reported in this paper.

1924 Forage Crop Experiments

These experiments were planned to study; (1) the comparative feeding value of alfalfa and rape when used with a ration of shelled corn, tankage and minerals; (2) the comparative value of shelled corn and ground barley when fed with tankage and minerals on rape pasture; (3) the relative merits of full feeding versus a three-quarter ration of concentrates on alfalfa pasture; and (4) the effect of the latter system of feeding when continued over a period of years on the stand and permanence of the alfalfa when the same number of pigs were used per acre in each case.

The alfalfa lots were seeded with barley the previous spring and a good stand was secured in each case. The two rape lots were sown with Dwarf Essex rape May 12 at the rate of eight pounds per acre and produced an abundant growth, in fact, owing to the wet season, considerable more than was required by the pigs.

The feeding period extended from May 24, 1924, to September 21, 1924, in the alfalfa lots, and from June 21, 1924, to September 21, 1924, in the rape lots. In each case the pigs were distributed to the different groups as equally as possible in regard to weight, age, breed, sex, type, condition, health, thriftiness and previous treatment. Each group had access to a portable cot as protection against inclement weather and the hot sun.

Each alfalfa lot was cut once during the summer for hay. The hay from Lot 1 weighed 1,790 pounds and that from Lot 2 weighed 1,945 pounds.

Feeds Used and Methods of Feeding

Lot 1 was given shelled corn, 60 per cent tankage, and minerals, all self-fed, free choice on alfalfa pasture.

Lot 2 received three-quarters as much shelled corn and tankage per day as the daily ration of Lot 1 for the previous ten day period, except that they were given more than this proportion of tankage during the latter part of the experiment. This was trough fed, on alfalfa pasture. A mineral mixture was available in a self-feeder.

Lot 3 was given shelled corn, 60 per cent tankage, and minerals, all self-fed, free choice, on rape pasture.

Lot 4 was fed ground barley, 60 per cent tankage, and minerals, all self-fed, free choice on rape pasture.

Each lot had access to fresh water in an automatic waterer at all times. No effort was made to record the amount of water consumed.

The mineral mixture placed before each group of pigs was composed of 30 pounds each of acid phosphate, finally ground limestone and common salt and 5 pounds of sulphur.

Table 1.—Results of Forage Experiments Conducted in 1924.

	Lot 1	Lot 2	Lot 3	Lot 4
	Sh. corn tankage minerals, all self-fed	Gr. corn tankage ¾ ration, trough fed minerals, self-fed	Sh. corn tankage minerals, all self-fed	Gr. Barley tankage minerals, all self-fed
Kind of pasture	Alfalfa	Alfalfa	Rape	Rape
Area of pasture	1 acre	1 acre	1 acre	1 acre
No. of pigs per lot	15	15	17	17
Av. initial weight per pig	34	32.6	44.76	44.71
Av. final weight per pig	169.66	132.02	141.12	139.02
Av. daily gain per pig	1.131	.829	1.047	1.028
Av. daily feed eaten per pig:.				
Shelled corn	3.475	....	3.311	....
Ground corn	....	2.344	....	....
Ground barley	....	....	....	3.997
Tankage	.194	.177	.269	.326
Mineral	.013	.010	.001	.005
Total	3.682	2.531	3.581	4.328
Feed required per 100 lbs. gain:				
Shelled corn	307.37	....	316.18	....
Ground corn	....	282 91	....	....
Ground barley	....	....	....	389.94
Tankage	17.20	21.32	25.70	31.81
Mineral	1.13	1.21	.12	.50
Total	325.70	305.44	342.00	422.25

Summary

1. Shelled corn, tankage and minerals produced somewhat larger daily gains with appreciably smaller concentrate requirements when fed on alfalfa pasture than when fed on rape.

2. Though the three-quarter concentrate ration on alfalfa gave considerable smaller daily gains, the feed requirements for 100 pounds of gain were about eight per cent less than in the case of the full fed lot. The latter lot was finished earlier in the fall and sold on a higher market.

3. The alfalfa in Lot 2 was pastured much more closely than was Lot

1, but no difference was detected in the strength of stand the following spring.

4. Ground barley, tankage and minerals fed on rape pasture gave slightly smaller daily gain and the concentrate requirements were much larger than when shelled corn, tankage and minerals were fed on similar pasture.

1925 Forage Crop Experiments

This experiment was conducted according to the same general plan as that covering the experiment discussed above, except for certain changes noted below.

Lots 1 and 2 were placed in the same alfalfa plots as were the corresponding groups of pigs the previous year. This was the second year this alfalfa had been pastured by pigs and while Lot 2 was grazed off quite closely the previous fall, both lots showed a uniform stand superior to that of the year preceding and produced sufficient forage for the pigs throughout the entire season.

Both alfalfa lots were cut twice for hay; Lot 1 produced 3,110 pounds and Lot 2, produced 2,765 pounds.

Lots 3 and 4 were sown with Dwarf Essex rape May 18 but on account of the dry spring and resulting poor germination, these lots were resown June 15. While the growth of rape was small when the pigs were turned in, there was sufficient forage throughout the entire experiment.

The experimental periods started May 27, 1925, on the alfalfa lots and July 7, 1925, on the rape lots, and were terminated from October 7 to October 25 when the pigs in the different lots averaged about 200 pounds each.

Table 2.—Results of Forage Experiments Conducted in 1925.

	Lot 1	Lot 2	Lot 3	Lot 4
	Sh. corn tankage linseed oilmeal minerals, self-fed	Sh. corn tankage linseed oilmeal ¾ ration, trough fed minerals, self-fed	Sh. corn tankage linseed oilmeal minerals, self-fed	Gr. barley tankage linseed oilmeal minerals, self-fed
Kind of pasture	Alfalfa	Alfalfa	Rape	Rape
Area of pasture	1 acre	1 acre	1 acre	1 acre
No. of pigs per lot	15	15	10	10
Feeding period	May 27 to Oct. 7	May 27 to Oct. 16	July 7 to Oct. 18	July 7 to Oct. 25
Av. initial weight	35.13	34.87	51.70	50.40
Av. final weight	208.43	200.23	198.80	200.40
Av. daily gain per pig	1.219	1.017	1.428	1.364
Av. daily feed consumed:				
Shelled corn	3.69	2.87	4.22	....
Ground barley	....	....	....	5.00
Middlings	.08	.08	....	....
Tankage	.23	.21	.47	.10
Linseed oilmeal	.23	.21	.47	.10
Minerals	.009	.009	.011	.014
Total	4.24	3.38	5.17	5.21
Feed required for 100 lbs gain:				
Shelled corn	302.55	282.60	295.72	....
Ground barley	....	....	....	366.34
Middlings	6.94	7.98	....	....
Tankage	19.20	20.51	32.83	7.50
Linseed oilmeal	19.20	20.51	32.83	7.50
Minerals	.71	.91	.75	1.06
Total	348.60	332.50	362.13	382.40

The same rations and methods of feeding were used in the different lots as in the corresponding lots during the 1924 forage experiment, except that Old Process linseed oil meal and 60 per cent tankage were used in equal parts by weight as the protein supplement instead of tankage alone and lots 1 and 2 were given a light feed twice daily for the first twenty days of the following mixture, 100 pounds ground corn, 200 pounds middlings, and 14 pounds each of tankage and linseed oil meal. This was trough fed in the form of a slop.

The mineral mixture given each lot was composed of 45 pounds special bone meal, 20 pounds finally ground limestone and 30 pounds common salt.

Summary

1. Shelled corn, tankage, linseed oil meal and minerals fed on rape pasture produced appreciably larger daily gains with somewhat greater feed requirements than did the same ration when fed on alfalfa pasture. This no doubt is due partly to the fact that the pigs on rape were considerably heavier at the beginning of the feeding period than were the other pigs when they were started on alfalfa.
2. Shelled corn, tankage, oil meal and minerals produced somewhat larger daily gains with considerable smaller concentrate requirements for the gains produced than did ground barley, tankage, oilmeal and minerals, each ration having been fed on rape pasture.
3. Lot 2, fed the three-quarter concentrate ration, made appreciably smaller daily gains but required a somewhat smaller amount of concentrates for the gains produced than did those receiving a full feed of similar feeds, both rations having been fed on alfalfa pasture.
4. Though the alfalfa in Lot 2 was pastured much more closely than was that in Lot 1 the stand did not appear injured.

General Summary

Averaging the results of the above two experiments the following summary is given:

1. Pigs fed on shelled corn, protein supplements and minerals on rape pasture made practically the same daily gains but required 55.67 per cent more protein supplements and a total of 4.15 per cent more feed for the gains made than did those receiving the same ration when fed on alfalfa pasture.
2. Pigs fed ground barley, protein supplements and minerals on rape pasture made practically the same daily gains, required 46.92 per cent less protein supplements, but a total of 14.57 per cent more feed for the gains made than did those fed shelled corn, protein supplements and minerals on similar pasture.
3. The limited ration of shelled corn, protein supplements, and minerals when fed on alfalfa pasture produced appreciably slower daily gains, required 14.45 per cent more protein supplements but 5.04 per cent less total feed for the gains made than did full feeding the same ration on a similar pasture.
4. The amount of feed required for the gains made on alfalfa and rape pastures was from 15 to 25 per cent less than is usually required with the same feeds when fed in a dry lot.
5. In addition to pasturing fifteen pigs throughout the season, Lot 1 pro-

duced an average of 2,450 pounds of hay and Lot 2 produced 2,355 pounds per acre each year.

6. Alfalfa and rape pastures have high feeding values for growing and fattening spring pigs and should be utilized more extensively for this purpose than they have been in the past.

SALT FOR HORSES

The Importance of Salt as a Factor in Successful Horse Feeding, is Realized by only a few Feeders

R. S. HUDSON, FARM AND HORSE DEPARTMENT

The custom of many farmers is to feed salt in the stable once a week or to go to the pasture on Sunday morning and throw several handfulls upon the ground where the colts and other live stock may lick it up. Horses confined in the stable usually get their salt in one of three ways:

1. Once a week in the box where grain is fed.
2. In a small box within reach of the horse where he may lick it at will.
3. A small quantity along with a feed of grain each day.

Fig. 1.—Percheron Mare Leila, 1926 Grand Champion at Chicago, and foal, illustrating the usual method of feeding salt to livestock.

There is probably no very accurate conception on the part of the majority of farmers or feeders as to the quantity of salt required for horses.

Henery's *Feeds and Feeding* says that "a reasonable allowance is two ounces per head daily." This fact is not generally known, even this statement does not in any way suggest the great variation in the quantity required by different animals or the change in quantity consumed at different seasons.

On May 1, 1925,—twelve horses ranging in age from 2 to 16 years, doing farm work and general hauling at Michigan State College, were selected for a trial to determine the amount of salt consumed by horses at different seasons.

Barrel salt was placed in small boxes fastened on the side of the stall over the mangers. Each horse was allowed all the salt he wanted and the amount weighed and recorded from time to time.

The test was closed December 22, and the salt remaining in the boxes was weighed and deducted from the amount put in at the last filling period. Table 1 shows the amount consumed by each horse in each month of the test.

Table 1.—Amount of salt, in ounces, consumed by each of 12 horses, May to December.

Month	Team 1		Odd horses		Team 2	
	Jasper oz.	Dexter oz.	Jirene oz.	Pat oz.	Baldy oz.	Nig oz.
May	32.0	56.0	24.0	24.0	16.0	8.0
June	28.8	48.0	16.0	24.0	8.0	24.0
July	104.0	120.0	28.8	88.0	8.0	65.6
August	123.2	147.2	73.6	72.0	118.4	92.8
September	96.0	136.0	64.0	48.0	80.0	80.0
October	72.0	104.0	32.0	24.0	64.0	56.0
November	64.0	64.0	32.0	40.0	32.0	24.0
December	80.0	96.0	56.0	80.0	24.0	11.2
Total	600.0	771.2	326.4	400.0	350.4	361.6
Month	Odd horses		Odd horses		Team 3	
	Joe oz.	Clyde oz.	Kate oz.	Don oz.	Dime oz.	Duke oz.
May	16.0	24.0	8.0	24.0	8.0	0.0
June	40.0	24.0	32.0	40.0	8.0	0.0
July	112.0	113.6	72.0	88.0	24.0	24.0
August	158.4	142.4	104.0	78.4	48.0	24.0
September	121.6	120.0	80.0	104.0	32.0	8.0
October	104.0	96.0	40.0	88.0	16.0	8.0
November	40.0	48.0	32.0	40.0	8.0	0.0
December	19.2	75.2	32.0	32.0	19.2	0.0
Total	611.2	643.2	400.0	494.4	163.2	64.0

Average Daily Consumption

The average daily consumption for the horses in the order in which they are named is,—2.54, 3.26, 1.38, 1.69, 1.48, 1.53, 2.59, 2.72, 1.69, 2.09, .69,

.27 ounces respectively, with an average daily consumption for the twelve horses of a little more than 1.82 ounces.

The foregoing figures show a great difference between the maximum quantity (158.4 ounces) consumed by Joe, a three-years-old Percheron gelding during August as compared with the quantity (24 ounces) consumed by Duke, a nine-years-old cross-bred Percheron Belgian during the same month. Duke consumed 64 ounces during the entire period of 236 days and Dexter, a five-years-old Percheron gelding consumed 771.2 ounces during the same period, or an average daily consumption of 0.27 for Duke as compared with 3.26 ounces for Dexter.

This table shows a constant increase in the quantity consumed by each animal from May to August, and a gradual decrease from that time to December when the test was discontinued.

It is evident also that a greater quantity was being consumed in December than in May. This fact cannot be attributed to the feed or to the work as is shown by the data in Table 2.

Table 2.—Age and handling of horses in test.

Team	Name	Age	Working	Pasture and no grain	Grain and idle
1	Jasper.....	4	May 1 to Nov. 1........	Nov. 1 to Dec. 22.......	....
1	Dexter.....	4	May 1 to Nov. 1........	Nov. 1 to Dec. 22.......	....
.....	Jirene......	3	May 1 to Dec. 22.......	Nov. 1 to Dec. 22.......	....
.....	Pat........	3	May 1 to Oct. 30........	Nov. 1 to Dec. 22.......	....
2	Baldy......	4	May 1 to Dec. 22.......	Nov. 1 to Dec. 22.......	....
2	Nig........	5	May 1 to Dec. 22.......	Nov. 1 to Dec. 22.......	....
.....	Joe........	3	May 1 to Nov. 1........	Nov. 1 to Dec. 22.......	....
.....	Clyde......	3	May 1 to Nov. 15.......	....	Nov. 1 to Dec. 22.
.....	Kate.......	16	May 1 to Nov. 1........	....	Nov. 1 to Dec. 22.
.....	Don.......	12	May 1 to Dec. 22.......	....	....
3	Dime......	8	May 1 to Nov. 1........	Nov. 1 to Dec. 22.......	....
3	Duke......	7	May 1 to Nov. 1........	Nov. 1 to Dec. 22.......	....

Table 2 shows that some of the animals not working were on pasture a part of the time receiving no grain. Others worked and received dry grain and hay throughout the period, while still others were kept in the stable after November 1 and received dry feed. In all cases, the amount of salt consumed by each animal decreased in about the same proportion after August which indicates that weather conditions influence the appetite for salt more than any other factor except individuality.

Conclusions

1. A wide variation exists in the amount of salt required by different horses as demonstrated by Dexter in team 1 and Duke in team 3.

2. The quantity of salt consumed varies with the season, increasing from May through August and into September, after which the weather grew cooler and the amount of work decreased, and the consumption of salt lessened.

3. Horses, therefore, should be given salt in such a manner that they may have free access to it at all times.

SEED CORN SHOULD BE TESTED CAREFULLY

Many Tests Show Condition to be Unusually Unsatisfactory

J. F. COX, FARM CROPS SECTION

It is now apparent that Michigan will be faced with a very serious shortage of good seed corn next spring. This condition is general throughout the corn belt and the northern states, and it is not likely that any other region growing adapted corn can be counted on to furnish Michigan with an appreciable supply of seed.

The fall was exceedingly misleading in that corn appeared to be well matured early. The unusually wet weather of the season, followed by early freezes, prevented corn in the field from drying out and when the freezes came, germinating power was seriously impaired.

Tests at the Michigan State College show that many seed corn supplies thought to be in good condition are giving a very low percentage of germination. Only those farmers who field selected their corn early in the fall and hung it up for proper drying can feel fairly certain of having good seed. Even these lots, however, should be carefully tested owing to the unusual fall conditions.

Supplies of old corn of good germination from last year's Michigan grown crop should not be fed out but should be held available for use as seed next spring by those who will be unable to secure good seed of high germination from the 1925 crop.

Conditions this year are apparently as serious as in the disastrous year of 1917. Every corn grower should test his seed corn supply for germination, and if it is found unfit, he should as soon as possible secure dependable seed grown in his neighborhood or from other producers growing similar corn.

Bulletin No. 289 "Corn Growing in Michigan," gives full information on testing seed corn. Copies can be secured, on request, from Director R. S. Shaw, Michigan Agricultural Experiment Station, East Lansing.

HARDY ALFALFA VARIETIES BEST FOR MICHIGAN

Seed from Regions of Mild Climate is not Adapted to this State

J. F. COX AND C. R. MEGEE, FARM CROPS SECTION

Experiments at the Michigan Experiment Station and the experience of many Michigan farmers established the fact that the planting in Michigan of unadapted alfalfa seed, produced in regions of mild climate, has been one of the chief factors responsible for alfalfa failures.

Large quantities of southwestern grown alfalfa seed, produced chiefly in Arizona, find their way to northern markets. In addition, large importations of alfalfa seed, chiefly from Argentina and from Mediterranean and South African regions, are frequent. This seed is seldom retailed in such a way as to describe truly its source.

The desirability of planting adapted strains produced under proper climatic conditions, has been fully established, but care must be exercised by all growers so that they may be assured that the seed purchased is of proper

Fig. 2.—A view of the series of alfalfa plats at the Michigan Station.
1.—Hardigan—a hardy Michigan grown lot. (Left)
II.—Hairy Peruvian—typical of seed from Arizona and other southwestern points. (Right)

variety and produced under climatic conditions which will enable it to withstand the climatic conditions of Michigan.

The seed planted in the tests herewith described was, for the most part, gathered at the thresher-spout in production areas, or secured from the Bureau of Plant Industry, United States Department of Agriculture and from dependable trade sources.

Table 1.—Yield Records of Alfalfa Series "A"—Seeded in the Spring of 1921.

Strain—Source	Yield—Tons of hay per acre—12 per cent moisture					
	1922	1923	1924	1925	Ave.	Total 4 yrs
I—						
Hardigan—Michigan	5.58	7.21	7.85	3.12	5.94	23.76
Grimm—Idaho	5.63	7.09	7.68	2.60	5.75	23.00
Grimm—S. Dakota	5.56	6.63	7.41	2.53	5.53	22.13
II—						
Common—Montana	5.11	6.39	7.36	2.52	5.34	21.38
Common—Kansas	5.28	6.45	7.18	2.27	5.29	21.18
Common—N. California	5.20	6.16	7.25	2.31	5.23	20.92
Common—Utah	5.15	6.06	6.92	2.07	5.05	20.20
Common—Idaho	4.91	5.48	6.51	1.87	4.69	18.77
III—						
Spanish—Spain	3.12	3.37	5.71	2.01	3.55	14.21
Hairy Peruvian—Arizona	3.83	1.11	1.74	0.32	1.75	7.00
Common—Arizona	3.90	0.92	1.55	0.38	1.69	6.75

In the spring of 1921, the Farm Crops Section established, at East Lansing, a series of alfalfa plats, using seed which had been secured from many of the larger seed producing sections of the United States and of foreign countries. The object of this test was to determine the relative value of seed from the various sources for Michigan conditions. The accompanying

Table 2.—Yield Records of Alfalfa Series "B"—Seeded in the Spring of 1922.

Strain—Source	Yield—Tons of hay per acre—12 per cent moisture				
	1923	1924	1925	Ave.	Total 3 yrs.
I—					
Hardigan—Michigan	5.96	6.24	2.86	5.02	15.06
Grimm—S. Dakota	6.23	6.18	2.74	5.05	15.15
Cossack—S. Dakota	6.23	6.21	2.68	5.04	15.12
Grimm—N. Dakota	5.99	6.02	2.83	4.94	14.84
Grimm—Idaho	5.88	6.12	2.76	4.92	14.76
II—					
Common—S. Dakota	5.64	6.23	2.75	4.87	14.62
Common—Oklahoma	5.81	5.94	2.51	4.75	14.26
Common—Kansas	5.46	5.71	2.71	4.62	13.88
III—					
Hairy Peruvian—Arizona	5.35	4.23	0.14	3.24	9.72

tables show the relative yields of air-dry alfalfa hay grown from seed from these various sources.

In the spring of 1922 another seeding, known as Series "B," was made. This series contained somewhat the same strains as Series "A" and shows the same results, as is shown by the data in Table 2.

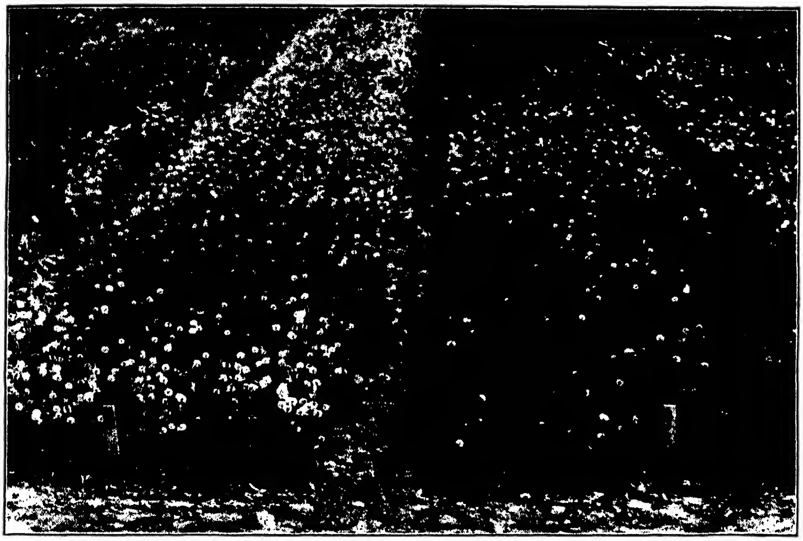

Fig. 3.—I.—Commercial Seed from South America winters kills badly and should not be used under Michigan Conditions. (Left) II.—Grimm, a hardy variegated strain, is exceedingly well adapted to Michigan conditions. (Right)

In the spring of 1923 another seeding, known as Series "C," was made. This series contains several imported lots which have demonstrated themselves to be decidedly inferior to domestic lots, as shown in Table 3.

Table 3.—Alfalfa Series "C"—Seeded in the Spring of 1923. Comparative Yields of Domestic and Imported Strains.

Strain—Source	Yield of hay—Tons per acre	
	1924	1925
Domestic—		
Hardigan—Michigan	5.43	3.03
Labeau—Michigan	5.41	3.25
Grimm—Idaho	5.38	3.25
Cossack—Utah	5.38	2.97
Grimm—S. Dakota	5.30	3.35
Common—Utah	5.29	2.73
Imported—		
Argentine—35° S. (Argentina)	5.29	1.45
Turkestan—Turkestan	4.57	1.91
Chubut—Argentine	4.13	1.03
Argentine—45° S. (Argentina)	4.06	0.96

The season of 1925 was exceedingly dry; consequently the yields of both the domestic and imported lots were somewhat less than for 1924. The imported lots winter-killed badly during the winter of 1923-1924, however, and their yield was reduced considerably more than that of the domestic lots.

In the spring of 1924 Series "D" was seeded on a well-drained piece of muck land. The Hardigan, Grimm, Cossack, and Ontario Variegated withstood the winter in excellent condition with stands of from 95 to 100 per cent. The South American lots, consisting of seed from San Rafaela Mendoza, Bahia Blanca, and Rio Negro suffered so heavily from winterkilling that the stand was not worth leaving. The South African lot completely winter-killed the first winter.

From the foregoing tests it is quite evident that the Hardigan, Grimm, Cossack and Ontario Variegated strains are winter-hardy, high yielding strains and exceedingly well adapted to Michigan conditions.

It is apparent that there are a few common strains which, when seeded under favorable conditions, will give fair yields but they are not as dependable as the Hardigan, Grimm, Cossack, or Ontario Variegated strains.

These tests show also that Arizona Common, Hairy Peruvian and other southwestern strains and the strains imported from Argentina, South America, and from South Africa are entirely unsatisfactory for seeding under Michigan conditions because of their lack of winter-hardiness and inability to yield.

COMMERCIAL SUGAR BEET SEED

The Results of a Test Conducted with 35 Brands of Commercial Seed

J. G. LILL, FARM CROPS SECTION

This report gives the results of the 1925 test under the field, soil, and seasonal conditions surrounding it.

These results were obtained by the compilation of the figures from the sixteen plots of each brand of seed tested. A standard brand of seed was planted in every third plot as a check. The results have been reduced to a direct comparative basis by approved methods.

The significance of these results have been determined by Student's method of statistical analyses. No result or figure is significantly different from the standard unless so indicated by the numerals following the number.

Results given with no qualifying figure indicate that the odds were about even that the difference between the result with any brand and the standard was due to change alone.

(1) This figure following any result indicates that the odds were at least 30 to 1 that the difference between the result with this brand and the standard was due to the quality of the seed.

Table 1.—The stand, the yield, the sugar content, the purity and the pounds of sugar per acre produced by the beets grown from each brand of seed.

Name of the brand of seed	No. beets per acre at harvest	Indicated yield tons per acre	Sugar content per cent	Purity factor per cent	Sugar per acre Lbs.
The Standard.—Average of 288 plots...	18602	14.831	14.21	90.31	4206.
Glostrup brand sugar beet seed........	20196 (2)	15.541	13.75 (1)	90.03	4299.
Braume Elite sugar beet seed.........	18097	15.560	13.46 (4)	88.74 (1)	4181.
Buszczynski Extra Productive.........	21074 (4)	14.262	14.95 (1)	91.65	4273.
Buszczynski Productive..............	19989 (1)	12.907	14.56 (1)	90.01	3722.
Dr. Bergeman's Querfurter...........	18306	14.363	14.31	90.53	4101.
Rimpau Original Klein Wanzleben.....	19876 (1)	14.231	14.97 (4)	91.21	4248.
R. & G. Old Type..................	19093	15.307	14.06	90.49	4313.
R. & G. Original..................	18622	13.490 (1)	13.84 (1)	89.37	3757. (1)
Vilmorin Brand....................	19453 (1)	15.280	13.58 (3)	89.37	4144.
La Fontaine Brand.................	17242 (1)	14.567	13.81 (2)	89.56	4027.
Desprez Brand....................	18624	14.412	14.22	90.81	4089.
La Graine Selectionee Brand.........	20538 (1)	15.482	14.80 (1)	90.72	4515.
Martin Brand.....................	20225	13.654	13.91	89.47	3768.
R. & G. Pioneer..................	20138	13.809	14.18	90.78	3802.
R. & G. Extreme Pioneer............	20382 (1)	13.279 (1)	14.49	92.25 (2)	3861. (1)
Edelsamen-Zuchterei Zahn—"P"......	20004 (1)	12.969 (1)	15.70 (4)	93.86 (4)	4079.
Edelsamen-Zuchterei Zahn—"C"......	18388	11.775 (1)	15.72 (4)	94.12 (4)	3701.
Sacharotrest (Russian Seed)..........	20962 (4)	15.964	14.05	90.07	4431.
Schreiber & Sohn's "S. S."...........	18695	17.512 (1)	13.86 (4)	90.51	4734.
August Knocke "A. K. Z." Brand......	18602	17.445 (1)	12.80 (3)	88.01 (1)	4406.
Michigan grown seed...............	20532 (2)	14.470	13.25 (4)	88.80 (2)	3803. (2)
Erhard Frederiksen "H. & H." Brand..	19145	14.196	13.84 (1)	89.96	3942.
Utah Idaho Grown (1920)...........	17565	13.944	14.18	90.80	3958.
Schreiber & Sohn's "S. K. W."........	18964	14.871	13.59 (1)	89.99	4055.
August Knocke "A. K." Brand........	18148	15.919	12.81 (4)	87.43 (3)	4076.
Number 27........................	19889	16.438	14.47	90.01	4728.
Horning sugar beet seed.............	20090 (1)	12.644 (2)	13.81 (1)	89.62	3478. (3)
Dobrovice Original.................	22097 (4)	15.572	14.16	91.27	4413.
Zapotil II/32......................	21472 (4)	14.119	14.67 (1)	91.71 (1)	4128.
Zapotil I/31......................	20964 (3)	17.107 (1)	14.42	90.82	4931.
Zapotil I/30......................	19714 (1)	15.946	14.47	90.95	4605.
Zapotil II/33......................	21282 (4)	20.121 (3)	14.09	90.66	5660. (3)
Number 34........................	19273	15.526	13.92	89.70	4305.
Number 35........................	20365 (3)	15.106	13.71 (3)	89.56	4133.
Canadian grown seed...............	22138 (4)	14.016	14.00	89.38	3926.

(2). This figure following any result indicates that the odds were at least 500 to 1 that the difference between the result with this brand and the standard was due to the quality of the seed.

(3) This figure following any result indicates that the odds were at least 1,000 to 1 that the difference between the result with this brand and the standard was due to the quality of the seed.

(4). This figure following any result indicates that the odds were at least 9,999 to 1 that the difference between the result with this brand and the standard was due to the quality of the seed.

CERTIFIED POTATO SEED

Growers may Increase the Yield and Improve the Quality of their Potato Crop by Planting Certified Seed

H. C. MOORE, FARM CROPS SECTION

Every potato grower should be vitally interested in those factors that favor more profitable production. Six years of tests comparing certified seed with ordinary seed, and the results secured by several hundred Michigan growers who annually plant approximately 100,000 bushels of certified seed give conclusive evidence that certified seed is highly improved seed, and is one of the most essential and economical factors in efficient production. Certified seed helps to insure profitable production by increasing yields 50 bushels or more per acre, thus lowering the cost of production per bushel, and by materially bettering the market quality of the crop so that it can be sold to the best advantage.

More economical production and a better quality of product should be the goal of the potato grower. Increased acreage based on anticipated high prices often leads to financial loss. The present high potato prices should not induce growers to expand their 1926 acreage. A shortage of the United States potato crop from the five-year average of approximately 88 million bushels accounts for the high prices now prevailing. The 1926 crop may be above normal and potato prices may be relatively low; hence the planting of certified seed and the following of other improved cultural practices that aid in efficient and economical production will be essential. Many growers have found that the use of certified seed has enabled them to reduce their potato acreage without reducing their annual output. Reducing the acreage has saved them considerable expense in cultivation, spraying, etc. Furthermore, it has made available more land for the planting of such soil improving crops as alfalfa, sweet clover, and clover.

Certified seed is improved seed because it has back of it years of careful selection and painstaking care on the part of its producers, who have complied with requirements maintained by the Seed Potato Inspection Service of the Michigan State College. Some of these requirements are here given since it is thought they will be of interest to prospective purchasers of certified seed, and because most of them could be followed advantageously by the growers of table potatoes.

Rules and Regulations Governing the Inspection and Certification of Michigan Seed Potatoes For 1925

1. The soil used for the potatoes which are to be inspected must be one which is capable of producing a good crop of clean potatoes when the weather conditions are normal. Potatoes must not be grown on the same

land more often than once in four years. Potato fields entered for inspection must be isolated from other potato fields.

2. Potatoes planted for inspection and certification must have been certified the previous season. Only high grade seed should be planted for certification. Culls, ill-shaped and otherwise undesirable potatoes from the certified stock may not be planted for inspection and certification. The seed bed must be thoroughly prepared so that it is deep and mellow and in good condition to hold moisture.

3. Growers who plant potatoes for inspection and certification must maintain seed plots and practice hill selection methods for improving the quality and yield of their stock. Wherever practicable the seed plot should be located 100 yards or more from any potato field. When the seed plot is located in the field listed for inspection and certification a strip of cultivated bare ground at least ten feet wide should surround it. This cultivated strip may be planted to corn if desired.

The seed plot must be thoroughly sprayed throughout the growing season for the control of early blight, late blight, aphids (plant lice), leaf hoppers, flea beetles, Colorado potato beetles, etc. The seed plot must be rogued at least five times during the growing season. The first rogueing should be made when the plants are about six inches high. The final rogueing should be made just before the vines mature or before they are killed by frost. The vines and tubers of all diseased, weak or off-type hills must be removed from the plot.

4. The seed must be treated with corrosive sublimate before planting.

5. Thorough cultivation must be given. Weeds and grass must be kept under control.

6. The potatoes must be dug and handled with sufficient care to prevent serious mechanical injury. They must be kept free from frost damage in field, transit, and storage.

To insure the fulfillment of inspection and certification requirements and the production of vigorous seed that is free from disease and varietal mixtures, trained inspectors working under the direction of the Michigan State College inspect all fields listed for certification, twice during the growing season. Those fields which do not have good stands of healthy plants are disqualified. Each year approximately 25 per cent of the inspected fields are denied certification. Some of the diseases which can be detected by field inspections are fusarium wilt, black leg, leaf roll, mosaic, etc. Several diseases, including leaf roll and mosaic, can be detected only in the growing plant as their symptoms are not manifest in the tubers. Field inspections, therefore, by technically trained inspectors are necessary.

Supplementing the field inspections, all lots of seed that pass the rigid field inspection requirements receive an inspection in the bin. At this time, the potatoes are examined for trueness to type, freedom from scab, rhizoctonia (black scurf), and other blemishes. To pass the bin inspection requirements, the seed must have all of the characteristics essential for high quality seed.

A fourth inspection is made at the time the seed is loaded in the cars for shipment. In this inspection, special pains are taken to see that the seed has kept well in storage and that it is carefully graded and properly loaded in the cars for shipment.

Certified seed is shipped in new sacks containing 150 pounds. Each sack is sealed with a lead and wire seal to which is attached the official certifi-

cation tag of the Michigan Crop Improvement Associaton. This organization is the official certifying agency, basing its certification upon the findings by the Seed Potato Inspection Service of the Michigan State College.

Certified seed of the Russet Rural, White Rural, Green Mountain and Irish Cobbler varieties can be purchased from the Michigan Potato Growers Exchange, Cadillac, Michigan, or from individual growers. Sources of certified seed and detailed information on the seed Potato Inspection Service can be secured by writing to the Farm Crops Department, Michigan State College, East Lansing, Michigan.

Growers intending to buy certified seed are urged to place their orders as soon as possible. The certified seed potato crop of Michigan is several thousand bushels short of normal, and the same seed shortage situation exists in other seed potato producing states. It is believed that the demand for Michigan certified seed by growers in other states will be exceptionally strong this year and it is hoped that growers in Michigan will be able to secure what seed they need. Wherever practicable it is suggested that certified seed be purchased in carload lots; in this way considerable saving can be made in the price of the seed and on freight rates. Furthermore, carloads of seed can be shipped during late winter or early spring without risk of the potatoes getting frosted in transit. By pooling orders with the local Farm Bureau, Co-operative Association, or dealer, growers can buy seed to the best advantage. With the high prices prevailing for table stock the difference in price this year between certified seed and U. S. No. 1 grade table stock potatoes is not nearly as great as it is in years of lower table stock prices. This is an exceptionally good time to replace poor ordinary seed with improved seed—certified seed is improved seed.

HOLLOW HEART OF POTATOES*

A Defect, Often found in Some Seasons, which may be Reduced by Proper Cultural Methods

H. C. MOORE, FARM CROPS SECTION

Potato hollow heart, characterized by a lens shaped hole surrounded by brownish discoloration of the flesh at the center of the affected tuber, is well known to growers, dealers, and consumers. The loss caused by this defect, when preparing potatoes for the table has long been a source of annoyance to the housewife, and a subject of severe criticism by consumers generally. Not until the last three or four years, however, has this trouble been considered of serious economic importance. The establishment of standard

*The writer wishes to express his appreciation for the valuable suggestions given by Dr. R. P. Hibbard, Plant Physiologist of this Station, in planning the experimental work, and to Mr. C. F. Behrens of the Farm Crops Department in collecting and tabulating some of the data here given.

potato grades throughout the country and the rigid inspections of potatoes by federal and state inspectors have forcibly brought hollow heart to the attention of all interested in the potato industry.

According to the requirements for the U. S. No. 1 grade, not more than six per cent by weight of the potatoes sold under this grade may show hollow heart. In the 1924 and 1925 shipping season many cars of potatoes from Michigan and other northern states were rejected because of excessively high percentages of hollow heart. Since this defect prevented the sale of the potatoes as U. S. No. 1 grade, it resulted in their being sold in many cases as U. S. No. 2 grade with serious financial loss to the shippers.

Hollow heart is not caused by fungus or bacterial pathogenes. It is believed to be a physiological trouble caused by conditions favoring excessively rapid development of the tuber. Without a doubt, the amount and distribution of rainfall during the growing season have a direct bearing on tuber development and the presence or absence of hollow heart.

In 1924, this disorder was of serious importance in all sections of Michigan, although in 1925 it was of little consequence and was restricted to a few sections. The average rainfall from June to September inclusive in 1924 was 3.26 inches, and for the same period in 1925 it was 2.91 inches, a difference of only 0.35 inches. By months, however the rainfall of 1924 exceeded that of 1925 by the following amounts: June, 0.82 inches; July, 0.21 inches; August, 1.29 inches. The September rainfall in 1924 was 0.89 inches less than that of September, 1925. It is believed that the rainfall in August, 1924, which was 0.77 inches above normal, was an important factor in causing serious hollow heart injury. The rainfall of August, 1925, which was 0.52 inches below normal, prevented excessive tuber development and made hollow heart a negligible factor. Bin inspection reports of certified seed potatoes in the fall of 1925 showed practically no hollow heart in the northwestern counties of the Lower Peninsula where drought conditions prevailed during the latter part of July and throughout August. In the central and southern counties where rainfall was about normal, a small amount was found.

Further evidence that rainfall is an important factor in causing hollow heart was obtained from a field experiment conducted in the summer of 1925 in which four plots of potatoes were irrigated with an automatic sprinkler, while the remaining four plots received no irrigation. A study of Table 1 shows that the irrigated plots 2 and 4 of the May 30 planting had an average of 10.37 per cent of hollow heart compared with 1.09 per cent for plots 1 and 3 which were not irrigated. In the June 25 planting, the irrigated plots (6 and 8) averaged 3.81 per cent hollow heart and plots 5 and 7 not irrigated, 0.85 per cent hollow heart.

The first application of water to plots 2 and 4 was made July 14; other applications were made at frequent intervals up to September 26. Plots 6 and 8 were first watered on August 19 and received frequent applications until September 26. The total amount of water applied to the irrigated plots was as follows:—plots 2 and 4, four inches; plots 6 and 8, 2.7 inches; plots 2 and 4 of the early planting received approximately 70 per cent of the irrigation water in August. It is thought that the heavy water applications made in this month were largely responsible for the increase of hollow heart in the irrigated plots. The rainfall in August was 2.13 inches, 0.50 inches below the normal precipitation. In the late planting, plots 6 and 8 received 1.4 inches of irrigation water in August and one inch in September. The total

rainfall for September was 3.88 inches which was 1.26 inches above the normal precipitation. The low percentages of hollow heart in the late planting are not so significant since the irrigated plots in this planting received less water than those in the May 30 planting.

In both the early and the late plantings, irrigated plots outyielded those not irrigated. In the early planting, the average size of the tubers and the percentage of oversized potatoes was greater in the irrigated plots. Potatoes of the late planted plots averaged 2.2 ounces smaller than those in the early planting and had no appreciable amount of oversized tubers.

Table 1.—Summary of data obtained from hollow heart field experiment.

Planted May 30

Plot No.	Treatment	Total No. lbs.	Spacing distance	Total No. bu. per acre	No. lbs. hollow	Per cent. hollow by weight	No. lbs. over size	Per cent over size	No. tubers in 20 lb. sample	Av. weight tubers (oz.)
1	Not irrigated......	230	36 x 18	307	0	0	7.9	3.43	57	5.6
2	Irrigated..........	215.7	36 x 36	290	33.5	15.43	16	7.41	32	10
3	Not irrigated......	183	36 x 36	244	6	3.28	5.2	2.84	44	7.3
4	Irrigated..........	310.5	36 x 18	412	16.5	5.31	16	5.15	48	6.7
	Planted June 25									
5	Not irrigated......	188.5	36x 18	251	0	0	0	0	72	4.4
6	Irrigated..........	206.2	36 x 36	275	10.5	5.09	3.9	1.89	57	5.6
7	Not irrigated......	187.5	36 x 36	250	3.2	1.7	3.9	2.08	56	5.7
8	Irrigated..........	276.5	36 x 18	369	7	2.53	1	.36	60	5.3

Number of rows per plot, 6.
Size of plots, 60 x 18 feet.
Variety—Russet Rural.

Date of first killing frost, Oct. 10.
Date of harvesting, Oct. 21.

In this experiment, the 36 x 18 inch spacing gave an average increase in yield over the 36 x 36 inch spacing of 34.6 per cent for the early planting and 18.1 per cent for the late planting. The average percentage of hollow heart in the early planting with 36 x 36 inch spacing was 9.35 compared with 2.65 per cent for the 36 x 18 inch spacing. The late planted 36 x 36 inch spacing gave an average per cent of hollow heart of 3.39 while the 36 x 18 inch spacing averaged 1.26 per cent hollow heart. This should be significant to potato growers since this result indicates that closer spacing reduces the amount of hollow heart and increases the yield.

Further information on the relationship of spacing distance to hollow heart development was obtained during the 1924-1925 shipping season, when 95 lots of certified Russet Rural seed potatoes were examined for hollow heart. The data obtained were compared with the field inspection reports which stated in detail the cultural conditions under which these lots were grown. Generally those lots showing the least hollow heart came from fields where close spacing was practiced. Fields in which the feeding area per hill was greater than 600 square inches had the largest number of lots showing hollow heart. In this study it was found also that the amount of hollow heart varied

inversely with the percentage of stand. Where there was a 90 per cent stand or better, there was considerably less than the average amount of hollow heart.

At present there is no evidence to indicate that hollow heart is hereditary or confined to certain strains. In the southern states it is seldom observed, though it is quite common in the seed brought from the north. There is a difference, however, in varietal susceptibility to hollow heart. Throughout the northern states potatoes of the Rural type, such as Rural New Yorker No. 2, Carman No. 3, Russet Rural, etc., are the most severely affected. Other varieties seriously affected are Irish Cobbler, Early Ohio, and Spaulding Rose. Green Mountain, Russet Burbank, Triumph, Peach Blow, and Downing are generally very free from hollow heart.

It is the opinion of some Michigan growers and dealers that the Russet Rural variety is more susceptible to hollow heart than the White or Smooth Rurals. This opinion may be erroneous since their observations have been confined mostly to the Russet Rural variety which constitutes approximately 90 per cent of Michigan's late potato crop. A survey made in the spring of 1919 to determine the relative susceptibility of these varieties to hollow heart did not show any difference between them. Counts on hollow heart, made when cutting the seed for strain tests in 1925 showed approximately the same percentages of hollow heart in Russet Rural, White Rural and Irish Cobbler. The few lots of Green Mountain seed cut had no hollow heart.

Other factors that may affect hollow heart, such as temperature, type of soil, chemical fertilizers, cultivation, etc., are being studied in greenhouse and field tests and more information may be available in the near future, that will help growers overcome this defect in their potato crop. In the meantime, it is believed that hollow heart in Michigan potatoes can be materially reduced if growers will follow the cultural methods that are generally recommended for the producton of good yields of high quality potatoes. Briefly these are:

1. Improve the moisture conditions of the soil by preceding the potato crop with alfalfa, sweet clover or some other legume in the rotation. Plow in the fall or very early in the spring, making the seed bed deep and mellow. By frequent harrowing keep the soil in a fine mellow condition until planting time.
2. Apply stable manure several months previous to planting. Supplement the stable manure with a high analysis commercial fertilizer applied broadcast or in the furrow.
3. Plant the best seed available—preferably certified seed, which has been treated with corrosive sublimate for the control of scab, black scurf and black leg. This precaution will help insure a good stand of healthy plants.
4. Use large seed pieces (1½ to 2 ounces) and plant the hills as close as soil moisture and fertility conditions warrant for a satisfactory crop. Generally on fertile soils the spacing should be 36 x 18 inches or less. Some growers on very fertile soils are getting the best results by planting at 36 x 12 inches. Under most conditions 36 x 36 inch spacing should be condemned since the potatoes usually grow too large and rough and frequently are hollow.
5. Plant sufficiently early so that the potatoes will mature before the first frost. Immature potatoes bruise easily in handling, become dark colored and are undesirable from a market standpoint.
6. Give shallow cultivation until the plants are in blossom to kill weeds

and grass and to keep the soil in a mellow condition. Late cultivations are of little benefit and often do much injury to the root system.

Frequent sprayings with arsenicals and bordeaux mixture should be given to ward off insect and foliage disease attacks. Every effort should be made to keep the plants in a thrifty condition.

7. Before placing the crop on the market, grade it carefully to conform with the Michigan Standard Potato Grades. Special precaution to eliminate hollow heart should be observed. All ill-shaped, rough or oversized potatoes should be sorted out, since usually hollow heart is most common in this class of stock.

FEEDING OF CONCENTRATES TO DAIRY CATTLE

Heavy Feeding of Concentrates Without the Proper Quality of Roughage is detrimental to the Animal

O. E. REED AND C. F. HUFFMAN, DAIRY SECTION

The tendency in dairy cattle management is to increase the proportion of concentrates to roughage in the ration in order to obtain increased growth in the young and greater milk production in lactating cows. A 1,000 pound cow producing 15 pounds of milk a day can obtain all of the nutrients needed for maintenance and production from alfalfa hay and corn silage. As the production increases it becomes a physical impossibility for the animal to consume sufficient roughage to meet the nutrient requirement. Hence the feeding of concentrates is necessary for high production.

The natural ration of the dairy cow, however, consists entirely of roughages in the form of grass and hay. The digestive tract of the ox is specially suited to disposing of roughage and is probably not adapted to a ration containing considerable grain in proportion to hay or pasture. Cattle in well fed herds appear to be more subject to disease than cattle in herds fed very little grain, which may be due to a lack of adaptability on the part of the ox to a large amount of concentrates in proportion to roughage.

Several investigators have found that calves can not be grown from birth to maturity on concentrates alone. Davenport of the Illinois Experiment Station was unable to raise calves on milk alone, or on milk supplemented with grain. He concluded that ruminants need roughage for proper physiological development. McCandlish of the Iowa Experiment Station also failed in raising calves on milk alone or on milk supplemented with various vitamines. However, when the milk ration was supplemented with alfalfa hay, normal health and development was obtained. Eckles of the University of Minnesota failed in raising calves on milk alone, but in one case where calcium carbonate was added to the milk diet the calf lived and did well until it was eight months of age when it was taken off the experiment.

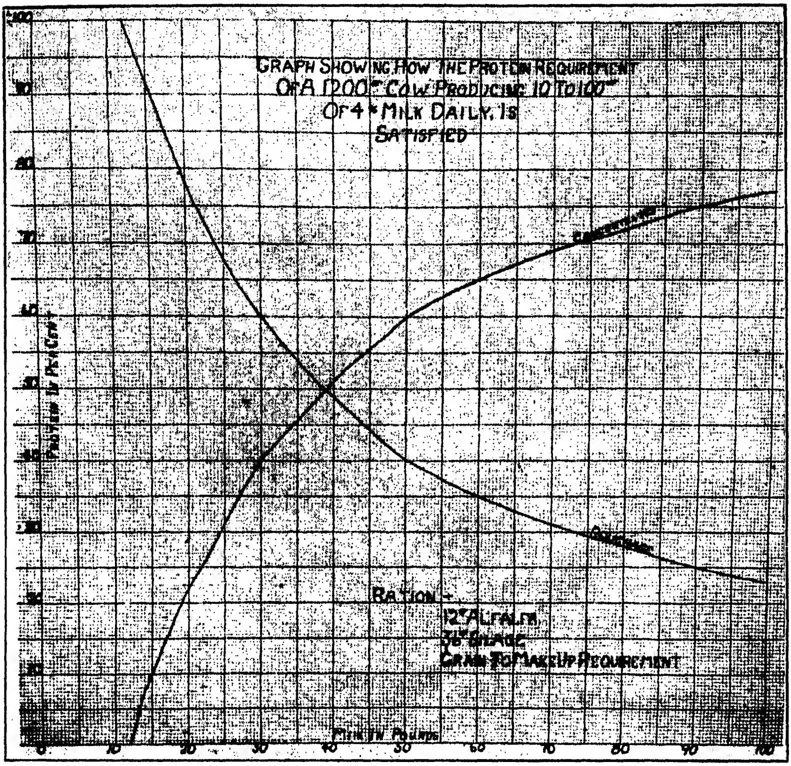

Fig. 4.—A graph showing how the protein requirement of a 1200 pound cow producing 10 to 100 pounds of 4 per cent milk daily, is satisfied. For example, a cow producing 60 pounds of 4 per ecnt milk per day would obtain about 65 per cent of her protein requirement from concentrates and only 35 per cent from roughage.

The effects of the heavy feeding of concentrates in proportion to roughages are being investigated by the Dairy Section in co-operation with the Sections of Chemistry and Animal Pathology of this Station. So far, 44 calves have been used in this investigation. We have so far been unable to raise calves to maturity on milk alone, on milk and grain, or on grain alone. Calves fed solely on concentrates die, showing symptoms of intoxication (convulsions or paralysis). Just previous to the onset of convulsions the animal appears excited. Usually the onset of convulsions is brought about by over-exciting the animal. At first the animal staggers and then falls and bellows as if in pain. The mouth remains open and there is frothing. The legs become rigid, muscles tense and hard and usually the animal kicks violently. Respiration is very difficult and in severe attacks entirely stops. Young animals as a rule do not die in the first convulsion, but may have an attack every few days for several weeks. However, in most cases calves more than eight months old usually die in the first convulsion. The post-mortem findings also indicate a toxaemia. The toxaemia is probably due to a deficiency of a

dietary factor other than crude fiber or bulk. Oat hulls in the ration of calf C-36 did not prevent convulsions and wheat straw failed to prevent evidence of toxaemia in calves C-13 and C-17. Furthermore, heifers 200 and 201 became stiff and emaciated on a grain ration supplemented with wheat straw ad lib. Calves that had access to shavings died with the same symptoms as those which were muzzled.

Fig. 5.—Calf C-1. Ration whole milk alone. Notice how front legs are bowed. (Left)

Calf C-1. After adding cod liver oil and calcium carbonate to the whole milk ration for one month. Notice how the front legs have straightened. (Right)

In many cases calves fed on concentrates alone develop a condition which resembles rickets in other classes of animals. The legs may become crooked and X-ray photographs of the ribs may show abnormal calcium and phosphorous depositions. Calves were fed whole milk supplemented with different minerals carrying calcium or calcium and phosphorus in an attempt to bring about normal development without roughage.

In the case of calves C-2 and C-12, calcium carbonate addition delayed the onset of the symptoms of irritability but death in convulsion followed eventually. Calf C-4 came down with convulsions on milk alone. The addition of 50 grams of calcium carbonate (precipitated) per day relieved the symptoms of irritability for a period of 90 days. The calcium carbonate was removed from the ration at this time and death in a convulsion resulted 22 days later.

Supplementing a whole milk ration with tricalcium phosphate failed to prevent convulsions in calves C-9 and C-15. However, in calf C-9 the irritability was relieved for a considerable period by the use of this substance. Raw rock phosphate or "floats" was fed as a supplement to the whole milk ration of calf C-5. Although no evidence of irritability was manifested, a stiffness of the joints developed, which was probably due to

the toxic principle encountered with this type of ration. This animal died from an attack of pneumonia at 303 days of age. It is apparent that the irritability in calves fed on a concentrate ration is not due to a calcium or phosphorus deficiency.

A grade Guernsey bull calf C-3 was placed on the following ration at 90 days of age:

Yellow corn	40 per cent
Wheat bran	25 per cent
Gluten (40 per cent protein)...	10 per cent
Linseed oil meal	15 per cent
Butterfat	5 per cent
Calcium carbonate	2 per cent (precipitated)
Bone meal	2 per cent
Salt	1 per cent
	100 per cent

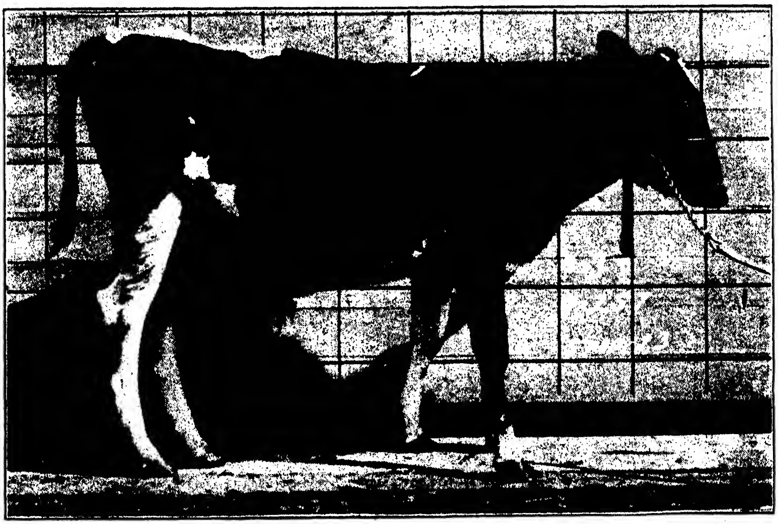

Fig. 6.—Calf C-3. Died of toxaemia on a ration complete in protein, energy, minerals and vitamines, but lacking in roughage.

This grain mixture is adequate from the standpoint of protein, energy, mineral and vitamines. The grain was fed ad libtum. Development was normal until the calf was 275 days old when the appetite began to fail. At 305 days of age a condition resembling pneumonia developed and death occurred after several hours of rapid respiration. Post-mortem examination revealed very little pneumonia. Petechiel hemorrhages were found on the heart and degenerative changes were found in the liver, which indicated that death was due to a toxaemia.

There is a wide variation in the ability of different animals to resist the

toxins encountered when fed a ration of concentrates alone. This difference is probably due to the fact that some animals inherit a stronger resistance than others. Furthermore, the nutrition of the dam affects the resistance of the young. The calves born from heifers No. 200, 201 and 205 indicate that the toxin produced on a ration of concentrates and straw is transferred to the fetus resulting in a weakened offspring. A function of the parathyroid gland is to counteract or prevent the production of toxins. It is likely that the parathyroid glands in different calves vary in their power to neutralize toxins; this may account for the difference in time required to bring about the onset of convulsions in calves fed on a ration of milk alone.

Calf C-4 came down in convulsions at 62 days of age and calf C-23 on milk alone had a convulsion for the first time at 83 days. On the other hand, calf C-42 lived 348 days on milk before the onset of convulsions, while C-40 has received a ration of milk alone for 14 months and is still alive. This animal has never had a convulsion although he is showing considerable stiffness in the legs. Usually, however, attempts to raise calves from birth to maturity on milk alone results in death at from 4 to 6 months of age. This problem is being investigated further. The deficiency produced by feeding concentrates alone is being compared with cottonseed meal injury, since the symptoms of the two diseases are very similar. Different iron compounds are being added to the rations of concentrates alone in an attempt to prevent intoxication. The effect of feeding different concentrate rations on the number of red and white cells in the blood of dairy calves is being determined.

The blood of these animals is analyzed by the Chemistry Section for calcium, phosphorus, chlorine and alkaline reserve in order to determine the effect of a concentrated ration on these blood constituents. Metabolism trials also are being run on some of these calves to determine the balance of calcium, phosphorous and nitrogen in the system.

The pathological changes brought about by the heavy feeding of concentrates to dairy cattle are being investigated by the Section of Animal Pathology.

THE NITROGEN CONTENT OF ALFALFA

This Factor Varies According to the Stage of Development and the Variety Grown

M. M. MC COOL, SOILS SECTION

The composition and quality of crops as affected by various soil types and their fertilization has received considerable attention from members of the Soils Section of this Station. In our studies of alfalfa, it has been found that the compositions of the roots and tops vary according to soil fertility, stage of development and the varieties grown.

Early in our work, it was shown that the young growth of alfalfa tops contains a very high percentage of nitrogen as shown by the analysis of this plant when cut at frequent intervals. In Table 1 are stated the results obtained from cutting Grimm alfalfa on the College Coloma sandy soil type during part of the growing season of 1925.

Table 1.—Nitrogen Content of Cured Alfalfa hay, clipped at short intervals. The normal nitrogen content at the ordinary time of cutting varies from 2½ to 3⅛ per cent.

Date of Cutting	Nitrogen Per Cent
July 19—first cutting	——
July 29	6.43
August 7	4.85
August 21	5.43
August 31	5.23
September 14	4.72
September 28	5.28

According to these results, if alfalfa is clipped frequently or grazed rather closely, the nitrogen content of the above ground portions will remain very high. It is apparent, therefore, that the feeding value of this forage crop would vary under different intensities of pasturing.

Samples of roots and tops of Grimm, Cossack, and a common variety of alfalfa were taken on different periods from our Co-operative Soil Fertility field on the farm of Mr. Bert Douglas, Texas Corners, Kalamazoo County, Michigan. This project is laid out on the Fox sandy loam type. The experiments were inaugurated in the spring of 1922. The samples were collected on different dates in 1924 and 1925. The results obtained from the unfertilized portion of the field are shown in Table 2.

Table 2.—The Nitrogen Content of Tops and Roots of Alfalfa. Date of Sampling and Nitrogen Content.

Tops	1924		1925				
	May 21	June 26	April 13	May 21	June 16	July 15	July 28
Grimm	4.09	3.07	6.13	3.55	2.91	5.89	3.97
Cossack	3.92	2.94	5.82	3.57	2.37	5.76	3.56
Common	3.72	2.77	6.07	3.21	2.28	5.56	3.40

Roots	1924				1925				
	April 8	May 21	June 26	Dec. 8	April 13	May 21	June 16	July 15	July 28
Grimm	2.30	1.73	1.73	2.72	2.87	2.11	2.53	2.85	2.54
Cossack	2.19	....	1.54	2.19	2.25	1.75	2.02	2.54	2.34
Common	1.91	1.70	1.80	2.07	2.46	1.59	1.99	2.60	2.16

According to these results the nitrogen content of the tops of the Grimm alfalfa, without one exception, was measurably greater at all periods than that of the other varieties. The Cossack variety with one exception contained more nitrogen than did the common variety used in our experiments. As in the previous experiments, the nitrogen content of the tops was greater in the early stages of development than it was in the later periods.

The nitrogen content of the roots was uniformly higher at all periods in the Grimm than in the other varieties. The samples of roots of the common variety sampled on June 26, 1924, April 13, 1925, and July 15, 1925, contained more nitrogen than the Cossack. Those collected on the other dates contained less.

LIME CARRIERS CONTAINING MAGNESIUM

Field Results on Fox Sandy Loam Soils, with Different Lime Carriers Show the Advantages of those Containing Appreciable Amounts of Magnesium

M. M. MC COOL AND G. M. GRANTHAM, SOILS SECTION

Experiments inaugurated in May, 1924, to determine the response to different lime carriers in soils of the Fox sandy loam soil type at the Barry and Kalamazoo County farms have brought out some interesting results. Similar responses have been obtained from greenhouse studies with soil taken from the Kalamazoo County Farm. In short, these investigations indicate very strongly that liming materials which carry appreciable amounts of magnesium are more valuable on the soils under investigation than those low in magnesium.

Liming materials that are applied to the soil may and usually do vary markedly in composition. Some limestones are made up in the main of calcium carbonate, others carry small percentages of magnesium carbonate along with the calcium carbonate, and still others contain more than 40 per cent of magnesium carbonate. It is not unlikely that rather wide variations exist with respect to the calcium and magnesium contents of marls taken from different deposits.

It has been known for a long time that lime from different sources may give various results when applied to different soils. Reports are on record which show that it is advisable to apply those that carry high percentages of magnesium rather conservatively to some soils. On the other hand, other reports show that some soils respond more to lime that contains large amounts of magnesium than they do to those that are low or are deficient in this element. Still other reports show that either may be used with success on some soils. So far as we have been able to determine, no systematic attempt has been made to correlate various soil types and their reaction to liming materials of different composition. In view of the fact that soil

types are inclined to be individualistic, that is to say, they may vary greatly in their response to a given treatment or treatments, it is not surprising that differences are sometimes obtained when attempts are made to meet the requirements of soils for lime by the addition of various materials to them.

The soil type from which these results were taken is described as the Fox sandy loam. The profile of this type is characterized by: (1) a light brownish surface soil to a depth of 4 to 6 inches; (2) pale yellowish sandy loam; (3) thence a coarse, sandy or gravelly clayey horizon changing abruptly to a (4) substratum of gravel and sand. The surface soil is for the most part a sandy loam, but as mapped it includes loamy sand and loam, both in places containing an admixture of gravel. A distinguishing peculiarity is the clayey horizon No. 3 which is encountered commonly at depths of 15 to 24 inches. This commonly has a reddish cast; the percentage of clay may be small but it is sufficient to bind slightly the coarse matter and render this layer a little less pervious than the material above and directly below it. The thickness of this layer varies from 6 or 8 inches to 2 or 3 feet; tongues of the reddish clayey soil may extend down into the gravelly substratum, but there is a fairly sharp plane of separation.

The structure is moderately pervious throughout so that the average quantity of moisture held is low, although the higher percentage of clay in horizon No. 3, checks slightly the downward movement of water and retains a higher quantity than either the soil above or the substratum.

The soil down to the gravelly substratum is, for the most part, medium in acidity; the substratum generally contains an appreciable percentage of limestone or other basic rocks and is alkaline. It occurs for the most part on nearly level or but slightly uneven plains, which are dry or well drained due to the pervious nature of the soil and free underdrainage in the gravelly substratum. In southern Michigan the greater part of this land was originally covered with hardwood, oak, hickory, hard maple, etc.

The greenhouse experiments were conducted by J. D. Romaine. The soil employed was taken from the Kalamazoo county farm, located near Galesburg, Michigan. A given amount of this soil was treated with precipitated calcium carbonate at the rate of 4 tons per acre. Another portion was treated with a mixture consisting of equal amounts of calcium carbonate and magnesium carbonate at the above rate. All portions received acid phosphate at the rate of 600 and potassium chloride at the rate of 100 pounds per acre. Four pots were filled with each lot of soil, moistened with distilled water and two of these were planted to inoculated alfalfa and two were seeded to sweet clover which had been inoculated. The moisture lost from the containers during the growing period was replaced at frequent intervals with distilled water. Four cuttings of alfalfa and one of sweet clover were harvested, the results being shown in Table 1.

The results presented in Table 1 show that the addition of the magnesium carbonate along with calcium carbonate to these soils reacts favorably under the greenhouse conditions. Very elaborate sets of field experiments were inaugurated in May, 1924, at the fields previously mentioned. They were laid out to determine the value of different carriers of lime, the duration of and the returns from limestones ground to different degrees of fineness and the best methods of applying them to the soil.

At the Kalamazoo county farm three liming materials were employed: (1) finely ground limestone, which contained about 8 per cent of magnesium

Table 1.—Results of Greenhouse Studies with Fox Sandy Loam Soil.

	Percentage yield (Calcium carbonate alone taken as 100)	
	Calcium carbonate	Calcium and magnesium carbonates
Alfalfa first cutting	100%	127%
Alfalfa second cutting	100%	116%
Alfalfa third cutting	100%	111%
Alfalfa fourth cutting	100%	110%
Sweet clover	100%	153%

carbonate, (2) medium finely ground limestone which carried about 42 per cent magnesium carbonate and (3) agricultural hydrated lime which contained about 43 per cent magnesium hydroxide. All plots received acid phosphate and potassium chloride at the rate of 200 and 100 pounds per acre respectively.

Table 2.—Yields of Alfalfa Obtained with Different Lime Carriers Applied at Varied Rates.

Material	Rate of application (pounds per acre)	Yield of dry alfalfa hay (pounds per acre)
1	2000	805
1	4000	1171
1	6000	979
3	1000	2832
3	2000	2556
3	3000	2625
2	4000	3482
2	6000	3436
2	8000	3225

The results reported in Table 2 show that the materials which contain the higher percentage of magnesium produced greater yields of alfalfa than did the one that carried a small percentage of this substance.

Only one cutting of alfalfa was taken in 1925 from the Barry county farm plots that had received applications of No. 2 limestone. On all other plots the alfalfa was a failure; the seed germinated and the plants grew for a short time, became yellow and finally died. A two-ton application of this lime resulted in a growth at the first cutting of 565 pounds, a three-ton application, 678 pounds and a four-ton application, 734 pounds per acre of dry alfalfa.

In addition to these results we have been informed by some farmers, who live on this type of soil, that they consider the high magnesium limestone to be better than those low in this substance.

The experiments inaugurated on these county farms are to be continued a number of years; others are under way and still additional experiments will be started to determine whether or not different soil types are in need of magnesium. In the meantime the writers suggest that those who have not had entirely satisfactory results from the applications of lime for the production of alfalfa and clover look up the composition of the materials used, as the indications are that some soil types may need magnesium.

LAND UTILIZATION IN SOUTHERN MICHIGAN

M. M. MC COOL AND F. W. TRULL, SOILS SECTION

One phase of the Michigan State Soil Survey program considers the land cover on the different soil types. Twelve square miles of Miami Loam in northern Washtenaw county and the same area of Hillsdale Fine Sandy Loam in southwestern Jackson county were studied at the close of the last soil survey season. The location, size and arrangement of the fields devoted to various crops, as well as the idle land and swamps, were determined by the field men as they traversed the areas on foot. In addition, a number of prominent farmers, whose farms were laid out on these and several other soil types respectively, have been visited and information obtained with respect to the utilization of their land.

The Miami loam is characterized by the following horizons: (1) a brownish gray loam to a depth of about 8 inches; (2) a yellowish brown loam somewhat mottled with gray, 8 to 14 inches; (3) a heavy, rather impervious and highly retentive clay which is dull yellowish brown, extending to a depth of 24 to 30 inches; (4) a heavy compact calcareous clay.

The topography of the Miami loam is rolling and the surface drainage is fair to good but the presence of clay at shallow depths makes tile drainage profitable. Stones are present, but not in large numbers. Horizons or layers 1 and 2 are somewhat acid and 3 and 4 are neutral to alkaline.

The Hillsdale fine sandy loam has a surface horizon of brownish sandy or fine sandy loam. At about 8 inches in depth the color becomes yellow and at about 14 inches there is a horizon of yellowish sandy clay which is fairly compact and retentive and which extends to a depth of about 3 feet; below this is a compact and fairly retentive yellow clayey horizon which may be somewhat mottled. The topography is more rolling than that of the Miami and the drainage is better. The stones, mostly sandstones, are very numerous on the surface and throughout the profile. This soil is acid throughout the entire profile.

The Miami soils are included in the most productive groups in the southern part of the lower peninsula. Clover usually does well on them without the use of lime, but as a rule best results from alfalfa are obtained when lime is added to the soil. The Hillsdale soils belong to the medium productive group of soils. They need lime, are not high in organic matter, and should receive commercial fertilizers regularly.

Figures 7 and 8 show the arrangement of the fields and the land utilization in the areas studied. Table 1 presents a summary of the field investigations on these soil types. The land utilization or cropping systems are somewhat similar on these soils. However, there is about 6 per cent less idle land included in the Miami; a much larger percentage is devoted to meadows, consisting of a mixture of timothy and clover, and a somewhat larger acreage to alfalfa, and in addition a larger percentage of the land is given over to pasture than in the Hillsdale type.

Somewhat different utilization is made of these types by some farmers,

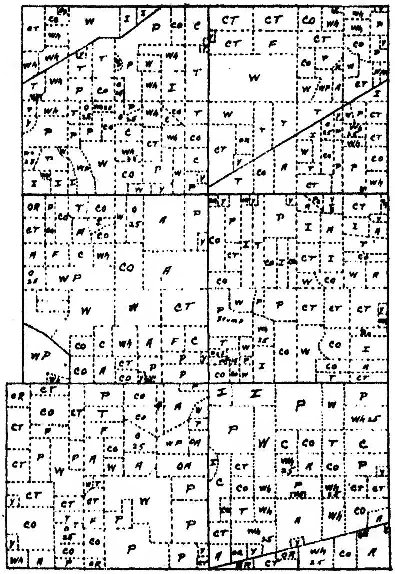

Fig. 7.—Land utilization, Miami Soils.

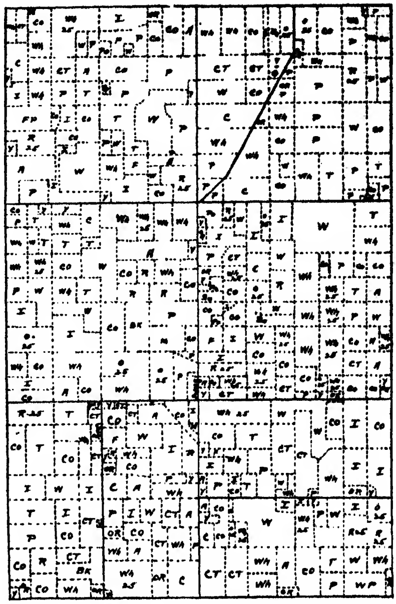

Fig. 8.—Land utilization, Hillsdale Soils.

who are considered to be successful, according to the studies of J. S. Hyde. The land covers for the individual farms as well as the average for the number investigated, are stated in Table 2.

Table 1.—Land Utilization on Miami and Hillsdale Soils Types.

Symbol	Crop cover	Hillsdale sandy loam per cent	Miami loam per cent
Wh 25	Wheat (1925)	5.27	4.70
OR	Orchard	1.97	1.81
A	Alfalfa	4.76	7.71
P	Pasture	12.31	14.54
Wh	Wheat	15.57	8.38
T	Timothy	5.75	5.53
R	Rye	2.02	....
CT	Clover and Timothy	5.25	12.94
W	Woods	9.94	15.01
Bn	Beans	1.70	.11
Co	Corn	12.22	13.96
F	Fallow	1.12	2.21
Y	Yards	1.63	1.44
O 25	Oats (1925)	2.84	2.66
I	Idle	8.40	2.45
Po	Potatoes	.39	.21
C	Clover	3.14	3.30
WP	Woods Pasture	.31	2.15
Bk	Buckwheat	1.55	....
M	Millet	.20	....
R 25	Rye (1925)	3.24	....
Su	Sudan Grass	.06	....
Ra	Rape	.02	....
FP	Fall Plowing	.26	....
Swamp	Swamp	....	.23
SP	Stump Pasture	....	.33
OC	Oat Cover	....	.21

Table 2.—Land Utilization by Some Successful Farmers. Percentage of Various Crops Per Farm on Hillsdale.

Farm	Corn per cent	Wheat per cent	Oats per cent	Alfalfa per cent	Meadow per cent	Woods pasture per cent	Orchard per cent	Waste land per cent	Wheat stubble per cent	Beans per cent	Sweet clover per cent
	Hillsdale Fine sandy loam—Jackson County										
Butler	21.8	9.0	......	20.0	11.8	25.0	1.2	1.2	10.0	......	......
Howard	28.0	14.4	14.4	7.2	14.4	17.6	......	4.0	......	......	......
Woodliff	30.0	30.0	......	......	30.3	6.6	......	2.5	......	......	......
Dawson	16.6	5.8	......	15.4	10.1	20.9	......	1.7	20.9	......	......
Dunham	15.0	18.8	......	13.8	18.7	25.0	3.7	5.0	......	......	......
Folks	10.6	13.0	......	7.0	14.1	34.1	......	2.4	18.8	......	......
Eckerson	17.5	16.6	......	16.0	12.5	17.5	3.3	1.6	15.0	......	......
Randolph	15.4	......	7.7	27.0	7.7	26.1	7.7	1.5	......	6.9	......
Average	19.4	15.4	......	15.1	16.1	21.6	3.6	2.5	16.2	......	......
	Percentage of various crops per farm on Miami Loam—Washtenaw Co.										
Cook	19.0	25.0	......	18.1	14.6	21.5	......	1.8	......	......	......
Kuhl	14.6	10.7	6.0	5.4	20.6	34.0	4.7	4.0	......	......	......
Bridenwishen	21.2	21.2	......	7.6	16.2	11.2	......	2.6	20.0	......	......
Stabler	20.0	10.9	......	15.0	15.0	17.5	5.9	1.7	5.8	......	8.3
Pratt	18.7	16.6	8.3	7.9	23.2	10.0	......	1.0	8.3	......	......
Average	18.7	16.8	......	10.8	19.1	18.8	5.3	2.2	11.9	......	......

The average acreage of alfalfa grown by the farmers on the Hillsdale soil type is nearly four times greater than the average of the majority of farmers as given in Table 1. One of these successful farmers does not grow alfalfa, but on the other hand 30 per cent of his land is in meadow. The acreage devoted to meadow by these farmers is likewise much higher than that of most farmers. The percentage of land in alfalfa and meadow ranges from about 21 to more than 34. The average percentage of Miami loam in alfalfa on the five farms visited is 10.8; the lowest is 5.4 and the highest, 18.1. The acreage devoted to this crop is 7.71 per cent of the twelve mile area. The successful farmers also have a higher percentage of their farms in meadow.

Several other points of interest and practical importance were brought out by these studies. In the Miami soils, tile drainage is common, lime is not used for clover or alfalfa, the latter being seeded not alone but with wheat, barley, or oats. Clover and alfalfa do not succeed on the Hillsdale soils without application of lime; when lime is used alfalfa may be seeded either alone or with barley, but the former method is most commonly followed. In addition the farms are larger and there are more cattle, sheep and hogs raised per farm on Miami than on Hillsdale soils. The average number of livestock on the Miami farms visited is as follows: Cattle 30, horses 5, sheep 112 and hogs 30; Hillsdale farms—cattle 14, horses 5, sheep 70 and hogs 39.

The average area of the first group of farms is 188 and the second 154 acres.

A study of the land cover in these areas indicates that a much larger number of the farmers could grow alfalfa profitably and in some cases the acreage should be increased on some farms that are now growing this crop. There is also a great opportunity for improvement in the quality and quantity of the pastures on these lands, especially by such practices as the production of sweet clover, and by the application of fertilizers to the land.

FERTILIZATION AND QUALITY OF MUCK CROPS*

Good Yields of High Quality Crops May be Produced on our Muck Lands when Properly Fertilized

PAUL M. HARMER AND A. G. WEIDEMANN, SOILS SECTION

The purpose of this article is to show how the quality of a muck crop may be greatly improved by proper fertilization. The first question is to measure accurately the quality of various crops in order to determine whether or not fertilization has benefited them. In 1922, fertilizer was applied on a corner of a worn-out muck pasture in Huron County. In order to show the farmer how much better yields would be secured from the fertilized portion, a portion of the field was fenced off. The cows cut their teats so badly breaking in to eat the fertilized grass that the farmer had to take down the fence, evidence that the fertilized grass was more palatable.

Chemical analysis has shown that fertilization of hay on muck land results in an increase in the protein content. The mineral content of the hay also is increased depending on the fertilizers added to the soil, such as potash or phosphate or both.

In so far as quality is concerned, the most abused crop grown on muck is probably the potato. It is a popular idea that muck potatoes are soggy and tasteless. A muck farmer recently received a letter from his parents in Indiana asking for some potatoes, but specified that they should not be potatoes grown on muck. Resenting the thrust at the soil of his choice, he secured some potatoes from fertilized muck and sent them. Later he received another letter saying, "Please send us some more potatoes, and by all means get them from the same place that you got the others, for they were excellent." Likewise, we have found in our experimental work, that the properly fertilized potato on muck soil is of fine cooking and eating quality.

Another important point in the consideration of quality in the potato is the size of the tuber. Table I presents a three-year average of potato

*Condensed report of a paper read at the Nineteenth Annual Convention of the American Peat Society, in joint session with the Michigan Muck Farmers Association, East Lansing, September 8-12, 1925.

yields on plots in Eaton County, with a uniform application of acid phosphate. The potatoes yielded 91 bushels per acre without potash, 251 bushels with 100,—331 bushels with 200,—and 381 bushels with 300 pounds per acre of muriate of potash. Without any potash, only 78 per cent of these potatoes were marketable, with 100 pounds muriate of potash, 93.2 per cent were marketable and with 300 pounds, 97.6 per cent were marketable. The average size of the potato was increased by the application of potash.

Celery, likewise is influenced in quality by fertilization. Celery that is well fertilized with a mixture high in potash produces a more stocky plant and stands up better in shipping, cold storage or on display. Celery that has been fertilized with potash has a distinctly better flavor than unfertilized celery.

Table 1.—Effect of different proportions of phosphoric acid and potash on the marketability of potatoes and size and number per hill.

Plot No.	Fertilizer application applied 1923-24-25—lbs. per acre	Total yield 3 yr. av. bu. per acre	Marketable potatoes—3 yr. av.			
			Yield bu. per acre	Per cent market-able	Av. wt. per potato-oz.	Av. no. per hill
1	P 300 K 0	91	71	78.0	3.1	2.4
2	P 300 K 100	251	234	93.2	4.9	5.2
3	P 300 K 200	331	321	97.0	6.2	5.7
4	P 300 K 300	381	372	97.6	6.5	6.1
5	P 200 K 300	361	351	97.2	6.4	5.8
6	P 100 K 300	315	306	97.1	5.8	5.6
7	P 0 K 300	276	268	97.1	5.8	4.9

*P—Acid phosphate (16% phosphoric acid); K—muriate of potash (50% potash).

There are a number of other vegetables, the quality of which is improved by fertilization. Of these, table beets, carrots, parsnips, onions, turnips and rutabagas, are crops we have studied. It is thought we have secured a measure of the effect of fertilization on the quality by a determination of the sugar content in the laboratory. It is a well known fact that, if a vegetable is not naturally sweet, it is not of the best quality.

In Table 2 are given the average yields per acre and sugar content of table beets on our plots near East Lansing for 1922, 1923 and 1924. The yields increased from 2½ tons without fertilizer to 3 tons with acid phosphate,—13 tons with muriate of potash,—19 tons with potash and phosphate,—and 19 tons with potash, phosphate and nitrate. The sugar (sucrose) content of these table beets averaged 4.2 per cent without fertilizer, 4.5 per cent with acid phosphate, 6.9 per cent with potash, 6.2 per cent with potash and phosphate and 6.3 per cent with potash, phosphate and nitrate. If calculated as pounds of sugar per acre, we increased the yield from 204 pounds without fertilizer to 2,231 pounds of sugar per acre with a potash and phosphate mixture.

As shown in Table 2, we secured for the same three years an average yield per acre of 9 tons of table carrots without fertilizer,—11 tons with acid phosphate,—16 tons with muriate of potash and 19 tons each with potash and phosphate, and with complete fertilizer. The average sugar (sucrose) content of these carrots increased from 2.2 per cent without fertilizer to 2.3 per cent with acid phosphate, 3.1 per cent with potash and 3.2 per cent with potash and phosphate, an increase of 50 per cent over the un-

fertilized plot. In pounds of sugar per acre, the yield increased from 419 pounds without fertilizer to 1,203 pounds with potash and phosphate, almost three times as much sugar from the properly fertilized plot as from the unfertilized.

Parsnips (Table 2) were the only crop which showed a decrease in sugar (sucrose) content when fertilized. A yield of 4.8 tons per acre was secured without fertilizer,—4½ tons with acid phosphate,—12½ tons with potash and 14 tons with potash and phosphate. The sugar content was 9.2 per cent without fertilizer, 9 per cent with acid phosphate, 6.7 per cent with potash and 8 per cent with potash and phosphate. The number of pounds

Table 2.—Effect of fertilization on yield and quality of table beets, table carrots, stock carrots, onions and parsnips on muck. (1)

Fertilizer application*	Table beets Av. 3 yrs.			Table carrots Av. 3 yrs.			Stock carrots Av. 2 yrs.		
	Yield tons per acre	Per cent sugar	Sugar lbs. per acre	Yield tons per acre	Per cent sugar	Sugar lbs. per acre	Yield tons per acre	Per cent sugar	Sugar lbs. per acre
No. fertilizer	2.5	4.2	204	9.1	2.2	400	5.8	2.0	226
K	12.7	6.9	1733	16.2	3.1	1004	9.6	2.8	551
P	3.0	4.5	258	11.4	2.3	554	6.7	2.3	314
P K	18.7	6.2	2231	18.8	3.2	1203	11.8	2.6	631
N P K	19.3	6.3	2232	18.8	......	......	11.6	2.8	674

Fertilizer application*	Onions—1924				Parsnips—1924				
	Mature onions bu. per acre	Per cent immature onions	Per cent sugar in mature onions	Sugar in mature onions lbs. per acre	Yield tons per acre	Per cent sugar	Sugar lbs. per acre		
No. fertilizer	212	42.1	0.8	92	4.8	9.2	883	......	......
K	597	9.3	1.2	387	12.5	6.7	1675	......	......
P	403	8.5	1.2	261	4.6	9.0	828	......	......
P K	629	3.4	1.0	340	13.8	8.0	2208	......	......
N P K	692	1.4	1.2	448	14.8	7.6	2250	......	......

*K—Muriate of Potash; P—Acid Phosphate; N—Nitrate of Soda.

(1) The Sugar determinations of the 1924 crops of table beets, table carrots (Table 3), parsnips (Table 4) and onions (Table 2) were made by O. B. Winter, of the Chemistry Section.

per acre of sugar, however, increased from 883 without fertilizer to 2,250 with complete fertilizer.

The onion crop (Table 2) shows marked benefit from fertilization, both in yield and in keeping quality. A set of plots in 1924 gave us yields of 212 bushels per acre without fertilization,—403 bushels with acid phosphate, —597 bushels with muriate of potash,—629 with potash and phosphate,—and

692 bushels with potash, phosphate and nitrate. The percentage of scullions, or immature onions decreased from 42 per cent without fertilizer to 8.5 per cent with acid phosphate, 9.3 per cent with muriate of potash, 3.4 per cent with potash and phosphate and 1.4 per cent with potash, phosphate and nitrate. The sugar (sucrose) content of the onions increased from 0.8 per cent without fertilizer, to 1.2 per cent with phosphate, 1.2 per cent with potash, 1.0 per cent with potash and phosphate and 1.2 per cent with potash, phosphate and nitrate. The yield of sugar in pounds per acre increased from 92 pounds without fertilizer to 448 with potash, phosphate and nitrate.

Table 2 also shows the effect of fertilization on yield and quality of stock carrots. As with the other crops so in this case the sugar (sucrose) content shows considerable increase from fertilization, the increase per acre amounting to approximately 200 per cent with complete fertilizer.

Of the other root crops studied, sugar beets have been most affected in sugar content by fertilization. Table 3 presents the average yields from three muck areas. On all three areas a large increase in yield and likewise a considerable increase in sugar (sucrose) content resulted from fertilization with potash or with potash and phosphoric acid. In table 4 are shown the yields of beets and

Table 3.—Effect of Fertilization on Yield and Quality of Sugar Beets on Muck.

Fertilizer application*	Lapeer Co., 1921			Gratiot Co. Av. 1922–3			Ingham Co. Av. 1922–3–4		
	Yield tons per acre	Per cent sugar	Sugar lbs. per acre	Yield tons per acre	Per cent sugar	Sugar lbs. per acre	Yield tons per acre	Per cent sugar	Sugar lbs. per acre
No. fertilizer	3.5	10.8	756	5.3	13.3	1410	3.2	11.9	762
K	12.3	14.1	3468	10.3	15.0	3090	6.8	14.3	1945
P	3.2	12.9	826	4.9	14.8	1450	3.9	11.4	889
P K	14.1	15.9	4484	12.0	15.1	3624	8.4	14.3	2402
N P K	16.2	16.2	5249	10.9	13.9	3030	9.6	14.0	2688

P—Acid Phosphate; K—Muriate of Potash; N—Nitrate of Soda.

Table 4.—Effect of Fertilization on Yield and Quality of Sugar Beets on Ingham Co. Muck—1924. (1)

Plot No.	Fertilizer application* lbs. per acre	Tons per acre		Per cent sugar	Sugar lbs. per acre	Per cent purity
		Beets crowned	Tops			
1	No fertilizer	3.6	2.2	14.1	1018	80.8
2	P 0 K 300	10.0	8.8	14.1	2814	82.4
3	P 100 K 300	12.1	10.4	14.4	3485	84.6
4	P 200 K 300	12.6	11.0	14.4	3614	85.0
5	P 300 K 300	13.2	12.0	15.1	3986	84.1
6	P 300 K 200	11.6	9.8	14.2	3303	83.4
7	P 300 K 100	11.6	7.9	13.4	3112	84.4
8	P 300 K 0	5.3	3.0	10.2	1083	78.5
9	No fertilizer	4.0	2.2	9.9	788	78.9

*P—Acid phosphate; K—Muriate of potash; N—Nitrate of Soda.
(1) Sugar and purity determinations made by the Lansing Sugar Co.

tops as well as the sugar content and purity in which various amounts of potash and phosphoric acid were applied. There is a very consistent agreement between the fertilization on the one hand and the yields of roots and tops, sugar content and purity on the other. This was the third year of similar fertilization of this set of plots, other crops having been grown previous to the sugar beets.

Discussion. With nearly every crop studied the application of phosphoric acid alone has produced little or no increase in yield or in sugar content and in some cases an actual decrease in one or both. In most cases, potash alone has given nearly as high sugar percentage as was secured by the additional application of phosphoric acid or phosphoric acid and nitrogen. In other words, the results indicate that for the production of a crop of high sugar content, a fertilizer mixture high in potash content should be used. It is a fortunate coincidence that the fertilizer which gives the largest increase in yield on our muck soils should also produce the best quality.

From the results we have given, it is readily seen that with most crops very good yields of excellent quality can be grown on the muck land of our state, if the muck is properly fertilized. With better storage and shipping facilities and the growing knowledge of the need of careful packing of freshly harvested crops, the time is not far distant when the Michigan muck farmer will find it essential to make a careful study of the needs of his particular muck soil for the production of a better yield of a crop of better quality. In the market where competition is growing keener each year, the muck farmer with a crop of high quality is not ashamed to label his product with his name and address, so that the consumer is able to return and secure more of his high quality muck product. The farmer with a crop of poor quality takes what he can get for his product, with the full knowledge that the consumer will not return for more.

IMPORTANCE OF BEES IN THE J. H. HALE PEACH ORCHARD

V. R. GARDNER AND STANLEY JOHNSTON, HORTICULTURAL SECTION

Investigations conducted by the Michigan Experiment Station have shown that the J. H. Hale peach is self-unfruitful under Michigan conditions. The fact that similar results have been obtained by investigators in other states indicates that this is probably a fairly constant characteristic of this variety and that if satisfactory yields are to be obtained suitable provision must be made for cross pollination. In the work of this Station,—the South Haven, Elberta, Kalamazoo and Banner varieties have all been found satisfactory pollenizers. Considering the commercial value of the varieties themselves and their blossoming seasons as compared with that of J. H. Hale,—South Haven is probably to be most highly recommended for interplanting with this variety for Michigan conditions.

Simply making suitable interplantings of two interfruitful varieties, however, does not guarantee a crop, nor does it even guarantee that cross pollination will be effected. In the case of most deciduous tree fruits, cross transfer

Fig. 9.—Bees were responsible for this difference. The upper figure shows the yield of an average J. H. Hale tree, six years old, where few bees were at work during the blossoming season and where the planting provisions for cross pollination were none too good. The lower figure shows the crop of a tree in the same orchard enclosed in a cage with an Elberta tree and with a swarm of bees.

of pollen is brought about almost entirely through the agency of certain insects and among these the common honey bee is of greatest importance. Since peaches have been regarded as self-fruitful, bees have not been generally regarded as necessary in the peach orchard. To obtain some measure of their importance in the pollination of the J. H. Hale some records were made in the Floyd Barden orchard near South Haven during the 1925 season. This orchard includes a planting of six rows of six-year-old trees of this variety bordering a planting of Elberta.

At blossoming time counts were made of the number of blossoms on small limbs here and there throughout the orchard, some on trees in the row adjoining and still others on trees in the row most distant from the Elbertas. All of these blossoms were open to chance cross pollination through the agency of bees and other insects. The trees carried only a light to moderate crop of blossoms. Though weather conditions during the blossoming season were reasonably favorable for pollination, there were not many bees at work in the orchard. At harvest time records were obtained of the number of fruits that had developed on the branches on which blossom counts were made. These records are summarized in the accompanying table and a part

Table 1.—Results of 1925 Pollination Experiments with the J. H. Hale Peach.

	No. blossoms counted	No. fruits matured	Percentage blossoms maturing fruit.
Blossoms on trees in row furthest removed from Elberta	1,057	84	7.9
Blossoms on trees here and there throughout the J. H. Hale block	10,463	844	8.1
Blossoms on trees in row adjoining the Elberta	591	81	13.7
Blossoms on trees in screen wire cage enclosed with Elberta and provided with bees	1,018	397	39.0

of them are translated into terms of crates per tree in the accompanying illustration. Twice as good a set of fruit was obtained on the trees adjoining the Elbertas as on those in more distant rows. However, there were not enough bees at work to provide for a full crop even on the trees in the row next to the Elbertas.

To furnish still more convincing evidence on the importance of bees in the J. H. Hale peach orchard, a screen wire cage was built around four average trees in this orchard, two Elberta and two of the J. H. Hale, and a swarm of bees was placed in this cage during the blossoming season. After the blossoming season the cage was dismantled and these four trees received the same spraying and cultural treatments as the other trees in the orchard. The results of this test are presented in the accompanying table and shown graphically in the accompanying illustration. Briefly, it may be said that the two J. H. Hale trees within the cage bore a full crop, about four times as much per tree as the other trees in the orchard. Every blossom did not set and mature fruit, and the trees did not require thinning, but at least they bore heavily. The inference should not be drawn from this experiment that a swarm of bees is required for each two J. H. Hale trees. Probably that one swarm of bees would have effected a fairly satisfactory cross transfer of pollen in the entire block of 175 trees had it been able to work freely in that one block and had the trees been planted so as to alternate a row of Elberta with every two or three rows of the J. H. Hale.

Incidentally, it may be mentioned that the two Elberta trees enclosed in the cage with the J. H. Hale set no better crops than trees of the same variety outside the cage, though each one of their flowers must have been visited by bees many times during the blossoming season. This indicates that bees are not of great importance in securing a good setting of fruit in orchards of self-fruitful peach varieties.

FROST PROTECTOR FOR EARLY PLANTING NO. II

All Protectors furnished Frost Protection; the Earliest Fruit was Secured from the Glassine, Waxed, Light Parchment and Heavy Parchment Protected Rows in the Order Named

R. P. HIBBARD, BOTANICAL SECTION

In the May, 1925, number of the Quarterly Bulletin appeared the 1924 report on the efficiency of different types of paper cones for frost protection. For the most part, this article referred to the effect of the cones on certain physiological processes taking place in the plant. In regard to the light, it was shown that all the cones reduced the intensity considerably and consequently interfered with the food manufacturing process. It was observed also that the type of paper influenced the amount of reduction. Finally a comparison of the dry weights of the plants grown in the open and under cones showed an increase in favor of the former. The facts seem to show that although the plants were protected, a prolonged stay under any type of cone would retard growth and delay development.

These experiments were done in the spring of 1924, which was late and thus interfered with the early plowing and preparation of the seed bed. No frosts occurred after the tomatoes had been planted so that an actual field trial on a large scale could not be used to show that the cones really protected. In the spring of 1925 conditions were better and we were successful in the preparation of a seed bed so that planting was made on May 8, about three weeks earlier than the usual time for planting in the field. Professor G. E. Starr of this Experiment Station, provided the seed for the experiment. It was a selection of his own development, called the June Pink. Germination of the seed was started in the greenhouse sufficiently early to provide about 600 seedlings from which to pick 408 uniform individuals for planting in the field. As is customary, germination was started in flats and the seedlings later transplanted into paper bands. When set in the field the plants were five inches tall and because of the rigorous selection, all were in a vigorous healthy condition.

The plants were set out in eight rows, four feet apart. In each row the plants were also four feet apart. There were 51 plants in a row, making in the whole field, 408. One hundred and fifty of these were put under cones, while the rest, 258, were used as checks. The plants in rows 1 and

8 were left uncovered and used as checks. Rows 2, 3, 4, 5, 6, and 7 were the experimental rows. Starting with the second plant in each row, the alternate plants were covered. In each row there were 26 uncovered plants and 25 covered. Celluloid cones were used for row 2; waxed for row 3; glassine for row 4; light parchment for row 5, heavy parchment for row 6 and celloglass for row 7. Fig. 10, shown below, indicates the manner of laying out the experiment. The picture was taken on May 29, eleven days after the last killing frost. On May 18 all plants not covered were destroyed by frost. None of the check plants, therefore, shows in the picture. As can be seen readily, a few cones are missing. These losses are due to cut worms and the unseasonably dry soil conditions prevailing. Cut worms took off 27 plants before they were controlled by the use of a poisoned mash, and 21 plants suffered from dry soil conditions.

Fig. 10.—A view of the tomato plats showing the different types of cones used in the experiment to protect plants from early spring frosts.

Climatic conditions were not good for young seedlings of any kind at this time. The soil was more than usually dry beneath the surface and like a fine powder on the surface. The wind was stronger than normal. Rain had fallen only four times during the 8-day period preceding the date of planting. The total precipitation was only 0.17 inches. On the 19th day of April, 20 days before the date of planting, the precipitation was 1.08 inches. For May the precipitation was only 0.70 inches, fairly well distributed in small amounts throughout the month. The largest fall was 0.34 inches on the 16th. Since the normal rainfall for May is 3.58 inches, the deficiency this year was 2.88 inches. The percentage of possible sunshine reached 74 according to East Lansing Weather Bureau reports.

The first killing frost occurred on May 18 and all the plants not covered were destroyed. Previous to May 18, only a few uncovered plants had been destroyed by heavy frosts. All plants under cones survived the frosts. There remained, after elimination of losses, 102 plants distributed under the different cones as follows: glassine 20, celluloid 16, waxed 21, light parchment 15, heavy parchment 14, and celloglass 16. A new type of cone was used for the first time in this experiment. It was the celloglass cone of rugged construction, easily set up and as easily taken down and packed away flat in storage when not needed. This is an expensive type, but it will last a long time.

The cones were not removed until first signs of crowding of the plant appeared. Then all were taken off. Three interesting things were apparent. First, there was a striking difference in the color of the plants. Those under the glassine and celluloid cones were a healthy green while the others were paler; those under glassine and celluloid had started flowering, while only a few scattered flowers appeared on the others. Those under celloglass had not flowered at all. The third and most interesting feature of all was the difference in the amount and type of growth shown by the plants in each row. These differences were largely maintained throughout the season. The tallest and slenderest plants were found in the waxed row. They were also a paler green but otherwise healthy and vigorous. Those in the glassine row were not so tall but considerably more bushy. Those under celluloid were similar to those under the glassine but not so large. Then followed the plants under light parchment, heavy parchment, and celloglass in the order given. Especially marked was the reduction in size of plants under celloglass. These cones under the conditions of our experiment do not prove up to expectations. Although these differences were so apparent to four different observers no picture of the field could be gotten to show them; consequently an average plant from each row was photographed.

Up to this point the experiment had shown that the various cones were all efficient protectors from frost injury and also that the various types of covers had their individual influences on certain physiological processes in the plant that led to the varying types of growth. It was now considered wise to let the plants mature and determine among other things the date of the first picking and the total yields for each row. Which row would show the first picking, the largest picking, and for these reasons the largest monetary returns? Ripe fruit appeared first in the glassine row and then in the waxed row. On August 12 the first picking was made. Six tomatoes averaging 89 grams each were gathered from the glassine row and 2 tomatoes averaging 88 grams each from the waxed row. The next picking was made on the 14th. Ten averaging 140 grams each were obtained from the glassine row and four averaging 97 grams each from the waxed row. On August 17, 26 came from the glassine row, 5 from the waxed row, 5 from the light parchment row and 3 from the heavy parchment row. None had yet been picked from the celluloid row or the celloglass row. On August 19, two were taken from the celluloid row. Not until September 8, almost four weeks after the first picking from the glassine row, was it possible to gather ripe fruit from the celloglass row. Thirty-two fruit were gathered, totaling 8 lbs. At this date glassine produced its largest crop of 159 fruit, totaling about 40 lbs. The pick from the glassine row maintained the lead until September 18 when it was replaced by the waxed row and then the celloglass row on the 23rd. The celloglass row remained high from this date until the frost.

It was interesting to calculate the yield and price value and make comparisons for each row. The earliest fruit would of course bring the highest price. Yield curves, price curves, and income curves were plotted. The results are described below, since space is not available for all the curves. Two pickings were made from the glassine row before a price* appeared on the market. While the first figures varied between $1.75 and $3.00, a bushel, 10 per cent of the entire crop from the glassine row was picked and ready for the market, while only 2.5 per cent of the waxed row, 3 per cent of the

*Detroit Farmers Market Report, 1925.

light parchment row, 0.6 per cent of the celluloid, 1.1 per cent of the heavy parchment and none of the celloglass were marketable. While the price was $1.00, 6 per cent more of the glassine row was marketable, as compared with 3 per cent of the waxed row, 2.5 per cent for the light parchment, 2.7 per cent for the heavy parchment and none for the celloglass. During the next week the price dropped gradually to 60c and remained so until the end of the next week. During this time 40 per cent of the crop from the glassine row was harvested while the waxed row had given only 24 per cent of its maximum yield. Light parchment had yielded 31 per cent, celluloid 19 per cent, heavy parchment 20 per cent and celloglass 5 per cent. From the 10th of September to the 13th the price fell to its lowest, 50c, and then gradually rose to the 23rd of September when it was $1.00. This price remained fixed until frost appeared on October 7.

Between September 10 and 23, when the price was the lowest and only gradually rose to $1.00, the celloglass row yielded its highest for any one period, 58 per cent. In the next period, one of two weeks duration, it yielded 38 per cent of its total crop; then the frost of October 7 stopped further production although the plants were fruiting well and growth was at its best. When the frost struck the row, it had on its hands, so to speak, 436 green tomatoes amounting to 85 lbs. of fruit while the glassine row had only 266 green fruit. The waxed row was high with 380 green tomatoes. By way of parenthesis it may be said that these green mature tomatoes can be ripened by treatment with ethylene gas, and thus more quickly prepared for the market, than by laying them out on benches in a greenhouse. Just at the time when the green tomatoes were brought in the writer was preparing to blanch some celery and as a matter of curiosity placed some tomatoes in the chamber with the celery. When opened, the tomatoes were ripened. Since then, J. T. Rosa of the California Station, has reported on extensive experiments in ripening mature green tomatoes. The report was made, and an abstract was printed at the A. A. A. S. meetings at Kansas City, December 28, 1925.

The glassine row, then, proved superior to any of the others from a monetary basis; gave greater yields, fruited first, and produced most of its crop before the frost arrived. The celloglass row on the other hand began fruiting last, yielded heavily when prices were low and lost a considerable number of fruit by frost. However it had fruit, which on the average was heavier by about 10 per cent than those in the glassine row. By reference to the table below it will be observed that in the matter of weight of individual fruit, waxed, heavy parchment, and celloglass ranked about the same. Some further points of interest can be gleaned from the table given below:

Table 1.—Yield data for each row of tomato plants.

Type of cone	Glassine	Waxed	Light parchment	Celluloid	Heavy parchment	Celloglass	Checks
Number of plants	20	21	15	16	14	16	258
Total yield ripe fruit. Grams	120,606	109,971	76,074	92,784	75,721	79,629	Froze
Aver. yield per plant in grams	6030.3	5236.7	5131.6	5799	5408.6	4976.8	....
Number of ripe fruit	1008	856	610	814	576	603	....
Aver. weight of fruit in grams	119.6	128.4	126.1	113.9	131.4	132	....
Green fruit remaining	266	380	174	267	260	436	....
Total weight green fruit in grams	20178	32929	14235	20,508	22520	38290	....
Dry weight of all plants	151.4	172.5	156	166.1	160.4	197.3	....

The total yield of ripe fruit was highest in the glassine row, and then followed, in descending order, waxed, celluloid, celloglass, light parchment and heavy parchment. The number of ripe fruit was highest in glassine, with waxed, celluloid light parchment, celloglass and heavy parchment following in the order given. The heaviest fruit was found in the celloglass row, while celluloid contained the lightest fruit. The fruit in the glassine row was next to the lightest. More green fruit, totaling the heaviest in weight, was found in the celloglass row. The oven dry weight of the plants in this row was greater than in any other row. This fact coupled with the above given data go to show that the plants had not matured and completed their functions before the frost killed them. Had the frost held off, higher results would have been obtained. The same might, in a lesser degree, be said of the plants in the waxed row.

Other types of paper cones are on the market and it is planned to set out another series this spring. The writer would appreciate correspondence from anyone interested in paper cones as frost protectors.

COST OF MAKING MAPLE SYRUP

Records of Maple Syrup Production at the College for the period 1916-1925

A. K. CHITTENDEN, FORESTRY SECTION

The Forestry Department of the Michigan State College has kept a record of the costs of making maple syrup in one of its woodlots since 1916. The costs have varied somewhat from year to year, with the total amount of syrup made and the character of the season. All labor connected with the operation is charged against it, as is all wood or fuel and other materials used. The number of trees tapped has varied from year to year.

The woodlot covers 55 acres and the maple trees are rather scattered, more so than in an ideal sugar bush. The amount of syrup during the past few years has been as follows:

Year	Number of trees tapped	Quantity of syrup made, gallons
1918	600	160
1919	623	81
1920	653	102½
1921	630	91
1922	640	150½
1923	640	81½
1924	none made	....
1925	588	138

The cost of making maple syrup, per gallon, in the College sugar bush in 1925 is shown in the following table:

Operation*	Cost per gallon of syrup	Per cent of total
Washing buckets	$0 15	6
Tapping	09	4
Gathering sap	71	30
Boiling	53	22
Gathering buckets	06	3
Fuel	42	18
Containers	20	9
Drawing water	03	1
Drawing wood	02	1
Depreciation on plant	14	6
Total	$2 35	100

Number of trees tapped	588
Total amount of syrup made, gallons	138
Amount of syrup per tree, gallons	235

*Man labor was charged at the rate of 40 cents and horse labor at 20 cents an hour.

The above record includes all costs of producing the syrup.

THINNING A WHITE PINE PLANTATION

A. K. CHITTENDEN, FORESTRY SECTION

A thinning recently made in the 34-year-old white pine plantation of the College near East Lansing gives some interesting data on the growth and development of this tree. The plantation was established by Dr. W. J. Beal in the spring of 1896. It has an area of about 3½ acres and is located on sandy and gravelly soil. Five-year-old trees were used with a spacing of eight by twelve feet, giving 454 trees to the acre. In the course of time the crowns of the trees completely shaded the ground and thus kept out weeds. The ground under the trees became covered with leaf litter and forest conditions prevailed. As the trees grew taller the amount of light available for the lower foliage was diminished and the lower branches began to die. Self-pruning, however, did not take place and the lower branches were cut off from time to time, the trees being pruned in this way to a height of fifteen feet. Self-pruning would have removed these lower branches in time, but with the wide spacing and the resulting small number of trees per acre the cost of hand pruning was small and a better grade of lumber, free of knots, will result.

Measurements of the volume growth per acre are made every five years but no thinning was done until December, 1925. Up to that time the growth in volume per acre in cords is shown in the following table. The table

also gives the number of trees per acre, the diameter of the average tree at a point 4½ feet above the ground, the height of the average tree, and the mean annual rate of volume growth per acre.

Table 1.—Rate of Growth per Acre of Pine Plantation.

Date	Total age, years	Number of trees per acre	Diameter of average tree, inches	Height of average tree, feet	Volume per acre, long cords	Mean annual growth per acre, long cords since 1896
1916..........	25	390	7.17	34.4	17.7	.70
1921..........	30	387	8.09	45.3	30.5	1.01
1925..........	34	381	8.70	54.0	42.8	1.26

It will be seen from this table that the mean annual growth in volume per acre is increasing but the actual present rate of growth is greater than this. For the five-year period between 1916 and 1921 the volume growth per acre amounted to 12.8 cords or an average of 2.56 cords per year. For the four-year period between 1921 and 1925 it amounted to 12.3 cords per acre, or an average of 3.07 cords per year.

The gradual decrease in the number of trees per acre is due to the crowding of the trees with increasing size and the consequent suppression and dying of certain trees to make room for others. As the trees increase in size they become crowded. The crowns do not have room to develop and the growth in diameter ultimately falls off. That this condition had been

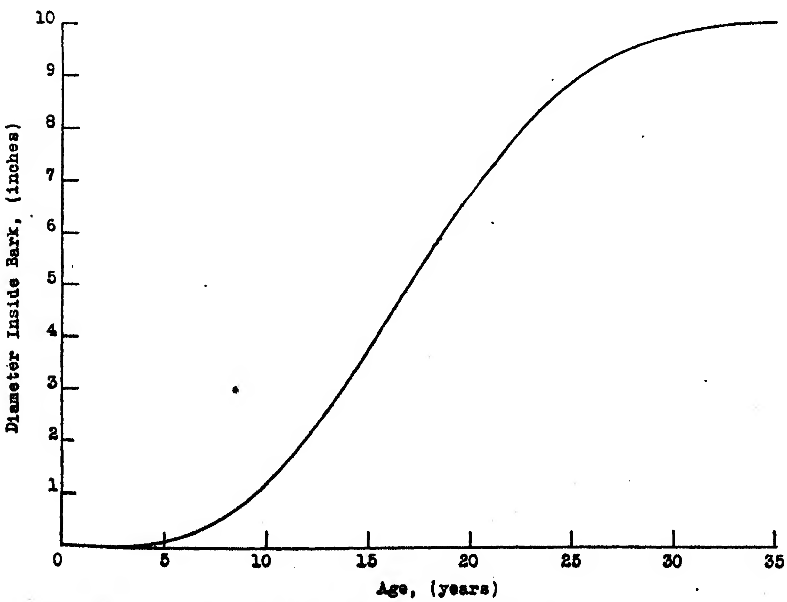

Fig. 11—Curve showing diameter growth of white pine before thinning.

reached in the plantation was evident from a study of the annual diameter growth.

Fig. 11 shows the average annual diameter growth inside the bark based on a ring count of the stumps of thirty trees. It took about four years for the seedlings to reach stump height and so for the first four years there is no growth indicated on the stumps. In the 10-year period between the tenth and twentieth years the diameter growth of the average tree was about 6 inches or 0.6 of an inch per year. In the 10-year period between the twenty-fifth and thirty-fifth year the diameter growth was only about one inch or 0.1 of an inch per year. Hence the rate of growth during the latter period had fallen off to only 16 2/3 per cent that of the former period.

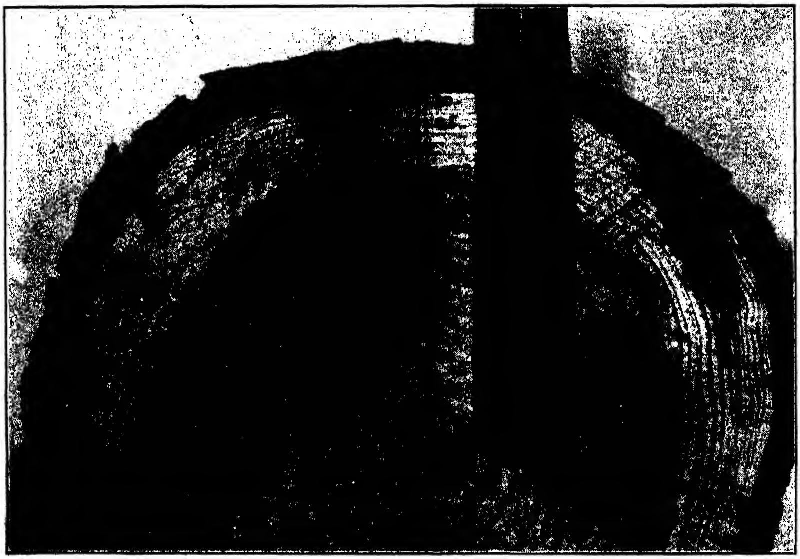

Fig. 12—Cross section on stump of white pine showing annual growth rings.

Fig. 12 shows the annual rings on the stump of an average tree. The dots at the right of the vertical line are placed on the annual rings and five-year periods of growth are indicated by numbers. Both the picture and the graph show that a thinning was desirable so as to increase the rate of growth.

The apparent discrepancy between the rate of diameter growth as indicated in Fig. 12 and in Table 1 is due to the fact that the graph is based on measurements inside the bark and the table is based on measurements outside the bark. The bark of white pine is also growing in thickness very rapidly when the trees are between twenty and forty years old.

A thinning was, therefore, made so as to open up the crown cover and give the remaining trees more side light. In this thinning the aim was to take out the inferior trees and leave the largest specimens. As, however, there was comparatively little to choose in point of size between the trees a certain regularity in thinning was adhered to and enough trees were taken out to leave a little open space around the crowns of the remaining ones.

Practically all the trees cut were in a sound condition and were free from disease and mechanical injuries, except that a few had broken branches.

The following table shows the average dimensions of the trees taken out in this thinning:

Table 2—Trees Cut per Acre in the Thinning.

Number of trees removed	Diameter of average tree, inches	Height of average tree, feet	Total volume removed per acre, long cords
128	7.3	49	9.1

Thus about one-fifth of the trees by volume and about one-third of the trees in number were removed in the thinning.

No large openings in the plantation were made. There are now left 253 trees per acre in the plantation. These trees have sufficient room to develop larger crowns and with larger crowns will again come faster diameter growth. The height growth of the trees has not shown any tendency to fall off. During the past nine years it has averaged 2.2 feet per year. With more room for the development of lateral crowns, however, it is to be expected that the height growth will fall off to some extent.

The unusually wide spacing with which the plantation was established is the reason for the early rapid diameter growth. With a closer spacing thinnings are necessary at an early age. It is desirable, however, to crowd the trees a little so as to force them to grow straight and tall, otherwise they will be largely crowns with heavy side branches and only a short clear length. Such a thinning should pay for itself in material removed.

THE HEMLOCK MEASURING-WORM

(Ellopia fiscelleria)

A Green Measuring-Worm which Defoliates Hemlock, Balsam, and to a Lesser Degree, Other Forest Trees

C. B. DIBBLE, ENTOMOLOGICAL SECTION

During the summers of 1924 and 1925 many hemlock and balsam trees in northern Michigan lost their leaves altogether or in part, because of a green measuring-worm which appeared in great numbers in the hemlock stands both in the resort districts and in those occupied by forest growth.

The "worms" when first noticed were dangling from the trees in mid-air,

suspended by fine, silken threads. Later, the infested trees began to appear scorched and dead, resulting in an appeal from the owners for advice and aid.

In response to this request, the writer was sent into the infested areas to obtain information about the creature that it might be combated to the best possible advantage. During the entire summer more or less constant contact was established with the pest and many new facts were secured.

Fig. 13.—Larva of Hemlock Measuring-Worm. Enlarged.

The "worms" were first noticed about the first of July and at that time were about $\frac{3}{4}$ of an inch in length. They fed voraciously throughout July and well into August, seeming to prefer hemlock and balsam needles, but as these became scarce, the "worms" turned their attention to many other forest trees, including arborvitae, white pine, white birch, soft maple, and beech. The leaves of these trees were eaten with apparent relish and at times the larvae did not refuse red pine, willow, tag-alder and elm. The work usually started near the top of the tree and progressed downward, the worms dropping from branch to branch on fine, silken threads which remained attached to the twigs and hung in tendrils and mats from the branches.

The trees gradually took on a scorched, or fire-swept, appearance when viewed from a distance, and closer observation showed them to be draped with masses of partly eaten needles entangled in the webbing and the ground beneath the trees was strewn with this material which had not been caught in the silken network.

As the season advanced, the worms became larger, reaching at maturity, late in August, a length of 1 to $1\frac{1}{8}$ inches.

Fig. 14.—Adult of Hemlock Measuring-Worm. Slightly Enlarged.

About this time they disappeared, but a search showed them, as expected, to be present but in a different form and in very inconspicuous places. They had crawled beneath the bark scales and dead bark, or into sheltered hiding places on the ground, and had become pupae.

This quiescent period lasted only about 10 days, after which each of the pupae released an adult moth. The moth is yellowish-tan in color with two distinct dark bands crossing each front-wing and with a dark dot midway between these bands and near the front margin. The rear-wing is crossed by a single dark band. The wings are lighter colored underneath and when spread, the moth is from 1⅛ to 1½ inches from tip to tip.

These moths are active at night, usually moving during the day only when disturbed. Mating takes place also at night, apparently about eight days after the moths emerge.

The gray-green iridescent eggs are usually placed singly beneath bark scales, or in protected places on coniferous foliage. These eggs later turn brownish. They are very small things, being smaller than the head of a pin.

It is in this form, as an egg, that the creature spends the winter. Sheltered somewhat from the cold, it awaits the warm sunny days of summer, when it hatches. Then, once again, a green looper will appear in the forest, searching with a seemingly insatiable appetite for the aromatic leaves of the hemlock or balsam.

The defoliation caused by these creatures is almost sure death to coniferous trees if it is at all severe, and when it occurs on two or more successive years, it is sure death to all of the conifers and to many hardwoods as well. Hemlock dies after one complete defoliation.

In view of this damage and the value of such trees, as timber and potential timber in the forest, and the aesthetic value of forest growth in resort regions, rather drastic control measures are warranted, even in spite of the expense involved.

The insect is a native of America and has several native parasitic enemies, but apparently these have been outdistanced, for a time, in the race for existence and the pest is likely to do more damage before these allies of ours are able to increase to sufficient numbers to again hold the creature in check.

As the hemlock measuring-worm has never been a common pest we can naturally expect that once its numbers are back to normal, heavy infestations will not recur for a period of years.

In the meanwhile it is essential that the trees which are endangered be protected until these natural enemies have an opportunity to multiply. The protection of forest areas always presents special difficulties because of the long rotations involved and the risk that money expended may be lost from fire or perhaps from other causes, before the crop is harvested. Spraying or dusting, as now carried on, in true forest areas are hardly practicable for this reason, and control of insect pests in such areas must be accomplished largely by means of cultural practices. The pure stands of any species always suffer more heavily, for obvious reasons, and in view of possible future outbreaks of this creature in the forests, pure stands of the preferred food trees, hemlock and balsam, should be avoided. It so happens that the commercial value of these species is low and that other trees will no doubt be encouraged in preference to them.

The resort, however, presents a different problem. Here we have a very high aesthetic property value placed on all trees and greater expense is war-

ranted to prevent the immediate loss of either individual trees or groups of trees. As this creature is a heavy foliage feeder, spraying or dusting with stomach poisons on the foliage, is called for. Spraying was tried at Leland, Michigan, during 1925 with a fair measure of success in spite of the fact that the spray was applied very late in the season. The number of larvae, pupae and adults decreased very materially wherever the arsenical sprays were used.

The arsenicals should be applied with high powered machines, in order that the tops of the trees may be reached, as soon as the worms appear. In spraying use 2 pounds of dry powdered arsenate of lead to 100 gallons of water, and in dusting use 10 pounds of arsenate of lead to 100 pounds of hydrated lime.

BLACK STEM RUST SITUATION IN MICHIGAN*

Oats, Wheat, Barley, Rye and about Sixty Wild Grasses are Subject to the Black Stem Rust

WALTER F. REDDY, ASSOCIATE PATHOLOGIST, OFFICE OF CEREAL INVESTIGATIONS, BUREAU OF PLANT INDUSTRY, UNITED STATES DEPARTMENT OF AGRICULTURE, STATE LEADER OF BARBERRY ERADICATION IN MICHIGAN.

Black stem rust of oats, wheat, barley, rye, and about sixty wild grasses is caused by a mold-like parasitic fungus. It is a low-type plant which steals its food from other plants and differs from the larger plants in not having definite roots, stems and leaves.

Its seeds are known as spores. The rust fungus produces more than one kind of spore. In summer it produces the red or summer stage on grains and grasses. As the grain ripens, the fungus produces the black or winter spores in late summer or fall. These spores do not germinate until the following spring. On germination, they produce a third kind of spore which is very small. These tiny spores are blown about by the wind and can cause rust only on the common barberry and several other harmful varieties of barberry, not including the Japanese variety, which is harmless.

On the barberry, the spring or cluster cup spores are produced. These do not infect barberry again. They are blown about by the wind and start the rust on grasses and grains, resulting in the formation of the red or summer stage. The red spores are blown long distances by the wind, can germinate immediately in water deposited on the plants by rain or dew and, under favorable weather conditions, may produce new crops of spores about

*The barberry eradication campaign in Michigan is carried on by the Office of Cereal Investigations, Bureau of Plant Industry, United States Department of Agriculture, Michigan State College of Agriculture and Michigan State Department of Agriculture co-operating.

once a week. Then, later in the season, the black or winter spores are produced again, and the rust once more starts its annual cycle.

At least three things are necessary for the development of a severe rust attack. First, there must be a source of rust in the spring. All the available evidence collected in Michigan shows the common barberry to be this source. Second, the rust spores must be spread by the wind to susceptible varieties of grains or grasses. Third, weather conditions must be favorable for the development of the rust. Weather conditions must be favorable because the rust is a minute living plant and, like oats or corn, it needs favorable weather for their development. Rust spores need moisture for germination, just as corn or wheat seeds do. Even after the rust spores have germinated and the rust parasite is inside of the grain plant, it cannot grow fast and produce more spores quickly unless the weather is hot and muggy. In order for rust to develop and spread, therefore, there must be plenty of moisture and fairly high temperatures.

Denmark proved conclusively the value of barberry eradication and by destroying the rust-producing species, as required by the law of 1903, stopped all serious outbreaks of black stem rust. The campaign to remove all of the common barberry bushes in the thirteen north-central grain-growing states of this country was started in 1918. The United States Department of Agriculture, the State agricultural colleges of the thirteen states, the State departments of agriculture, the Conference for the Prevention of Grain Rust, and similar allied agricultural and business organizations are co-operating in the campaign. The chief phases of the campaign are investigations, publicity, survey and eradication.

Careful and extended epidemiology studies in Michigan reveal the following results: (1) The red or summer spores of the rust do not overwinter in Michigan. In the summer or growing season the red spores, after they are once started, are capable of infecting certain grains and grasses and function independently of the barberry. If these spores did live through the winter in Michigan, then they could infect fresh-growing grains and grasses during the following spring and summer. (2) Spores, known as aeciospores, develop on common barberries in Michigan about a month previous to the appearance of rust on grains and grasses. (3) Grains and grasses near infected barberries become rusted from two to three weeks before stem rust appears on similar grains and grasses farther from the infected barberries. (4) It is possible to find the barberries in most cases by tracing stem rust epidemics from areas of light infection to areas of heavier infection. Common barberries are the source of the epidemics.

Malarial fever was controlled by destroying or removing the breeding places of the malaria-spreading mosquito. Black stem rust can be controlled by the eradication of the rust spreading barberries. When the campaign was inaugurated it was thought that the majority of barberries would be found in city parks, cemeteries, houseyards and, in general, where landscape gardening was extensively practiced. Thousands of common barberries have been removed from the cities, but field observations indicated that many bushes were in the rural sections. A thorough search in these sections of Michigan has shown that barberries has been planted over a hundred years ago by our early farmers. The bushes have produced great crops of berries. The seed were scattered by birds to woodlots and pastures. Extensive areas of escaped bushes have been found in Michigan and the finding and eradicating of these escaped bushes are the difficult problems of the campaign. Michigan has

more areas of escaped barberries than any other of the thirteen states engaged in the campaign.

Every common barberry bush in Michigan must be eradicated. Many people evidently do not understand that barberry bushes can spread rust long distances. The bushes do not have to be next to a grain field in order to do damage. They can spread rust to wild grasses from which it then spreads to grain fields. Heavy local epidemics of rust have been traced five to ten miles from the bushes. Cluster cup spores have been caught by means of airplanes 7,500 feet above the surface of the earth. Naturally they are going to travel some distance when they get up that high. Therefore it is quite possible that they occasionally may start rust several hundred miles away from the bushes on which they were produced.

Survey activities are divided into three phases, namely, original survey, second survey, and resurvey. The original survey is a property-by-property survey in cities, towns, and villages and a farm-by-farm survey in the country. During the period of the campaign in Michigan the original survey has been completed in 61.3 counties of the lower peninsula. A second survey now means a second complete original survey of every foot of every rural and city property on which barberries may possibly be growing. A second survey is necessary to locate bushes, escaped bushes and seedlings which were missed on the original survey. The larger number of bushes found on second survey were those that had been cut down by property owners previous to the original survey and had grown again. It will be necessary to cover by second survey all of the counties in which fruiting bushes have been found. This survey has been completed in three counties. As barberry seeds may remain in the soil for five years, and possibly longer, before germinating, re-surveys are necessary. A re-survey is a re-visit to the properties on which barberries have previously been found and eradicated. Two years after the bushes are eradicated the properties are reinspected and sprouts and seedlings are removed to prevent the possibility of their becoming infected and starting anew the stem rust epidemics. The re-surveys have been combined with the second surveys whenever practicable. In all, twenty Michigan counties have been covered in the re-survey.

The common barberry is very difficult to kill by digging, but is readily killed by certain chemicals. When the bush is close to valuable plants or trees it is dug or pulled because of the possibility of damaging the other plants by an application of chemicals. Many seedlings and small escaped bushes are not treated, since the entire root system can be pulled easily. Approximately forty different chemicals were tested under laboratory and field conditions. It was demonstrated that common crushed rock salt and kerosene are, in every respect, the most satisfactory chemicals with which to kill the common barberry.

During the campaign in Michigan, 61.3 counties, representing an area of 57,480 square miles, have been covered in the original survey; 3 have been surveyed a second time; and 20 counties have been covered in re-survey. A total of 481,700 bushels were found on 10,516 properties and 458,783 bushes were eradicated from 9,841 properties. Seedlings numbering 1,544,273 have been found and destroyed. Of the number of bushes found, 427,716 were in the rural sections. The startling number of 357,934 escaped bushes were eradicated from 1,779 areas of escaped or "wild" bushes. If all the bushes were located in one area, the damage would be great for that particular area. Unfortunately the bushes are distributed over the entire state.

There is no grain field in the entire lower peninsula which is sufficiently removed from rust-spreading barberries to escape an attack of the rust under favorable conditions.

You can help bring this campaign to a successful conclusion by (1) teaching the story of common barberry and black stem rust to your friends and neighbors; (2) stand behind the federal, state, and private appropriations to finish this big job; (3) learn to know the common barberry and hate it as you would a rattlesnake.

If you find a common barberry anywhere in the State, report it at once to the Department of Botany, State Agricultural College, East Lansing; the State Department of Agriculture, Lansing; or the United States Department of Agriculture, Washington, D. C. They will tell you what to do with it.

OBITUARY—PROFESSOR LESLIE H. COOLEDGE

F. W. FABIAN, BACTERIOLOGICAL SECTION

The dairy industry in particular and bacteriology in general, lost a very valuable man in the death of Professor Leslie H. Cooledge, of the Michigan State College, on May 14, 1925.

Mr. Cooledge was born August 30, 1888 in DeSmet, South Dakota, where he received his early education in the grade schools and was graduated from the high school in 1907. He then entered the South Dakota Agricultural College and was graduated from this Institution in 1911, with the degree of bachelor of science. After receiving his bachelor's degree he did graduate work at the University of Wisconsin during the summer of 1911 and later entered the University of Missouri where he received his Master's degree in June, 1913, working with Eckles and Palmer.

After completing his graduate work he came to Michigan State College as Research Assistant and Instructor in the Department of Bacteriology and Hygiene; where he worked until his death.

His early training and chief interests were with the dairy industry. He is best known in the field of market milk where he did much valuable work. His most important contribution in this field was his work on the colorimetric hydrogen-ion method for determining the keeping quality of milk. This method is finding very wide application today and bids fair to come into general use in many laboratories. In addition to his work on the hydrogen-ion method, he had completed other equally valuable pieces of work for the dairy industry. Especially notable was his work on the nature of abortion infection of the udder and its influence on the milk, and through the milk on man and the lower animals.

Although he was but thirty-seven years of age and had been out of college only twelve years, yet in this short space of time he had completed and published twelve scientific papers worthy of note. Those who knew him best will not marvel at this, however, for he was a tireless worker. He thought in terms of his work. He had few outside interests. His entire time was devoted to his profession to which he gave his all. His was a truly

scientific mind, orderly, masterful, and conservative. He never formed an opinion and then tried to make the facts conform to it. Rather he procured the results and drew his conclusions in the light of the facts.

Mr. Cooledge came from a family of engineers. In fact he studied engineering at one time but becoming interested in bacteriology, he abandoned engineering as a profession and pursued the subject of his choice. The genius of the engineer was ever cropping out in him, however, and just before his death, he had perfected a milk cooler that has exceptional merit, and which may be on the market in the near future. The Cooledge Comparator, which he perfected, and which is now on the market, is another evidence of the genius of the engineer in him.

He was a member of the American Dairy Science Association, the American Society of Bacteriologists, the Michigan Milk and Dairy Inspectors' Association, of which he served as secretary for several years, the American Chemical Society, the International Milk and Dairy Inspectors' Association, of which he was a member of the committee on standard methods for the bacteriological examination of milk, Sigma Xi, and of Delta chapter of Alpha Chi Sigma.

During the war he enlisted as a private in the Medical Corps and later was advanced to Sergeant, first class. His major duty was in bacteriology, serving both in this country and in France.

In June, 1924, he was married to Sarah M. Olsen of Muskegon, Michigan, a graduate of Michigan State College.

Those who knew Mr. Cooledge will remember him as a quiet unassuming man with rare good judgment, poise and a fine sense of humor. Nothing ever seemed to ruffle or excite him. Of all the fine qualities characteristic of the man, the outstanding one was that he was a gentleman—not a gentleman of acquired manners, but one of instinctive courtesy, consideration, unselfishness—it spoke in every action. It was these qualities that made him beloved and highly respected by those who knew him.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, Agricultural Experiment Station, East Lansing, Michigan.

LIST OF AVAILABLE BULLETINS

Regular Bulletins—

251 Insects of 1907.
258 Insects of Field Crops.
262 Suggestions on Planting an Orchard.
264 Second Report of Grade Dairy Herd.
267 Michigan Weeds (only to libraries and teachers).
273 Utilization of Muck Lands.
277 Studies in the Cost of Market Milk Production.
281 Trees, Shrubs and Plants for Farm and Home Planting.
284 Some Information and Suggestions Concerning the Use of Phosphorus.
286 Studies and Cost of Milk Production—No. 2.
289 Corn Growing in Michigan.

Special Bulletins—

58 Foul Brood.
65 Hog Cholera and Preventive Treatment.
70 Michigan Agriculture, Its Present Status and Wonderful Possibilities.
71 Studies in the Range and Variation of the Percent of Butter Fat in the Milk of Individual Cows.
72 Some Ginseng Troubles.
74 Analysis of Some Materials Sold as Insecticides and Fungicides.
76 Transferring Bees.
79 Michigan's Shifting Sands; Their Control and Better Utilization.
80 Yellow Rocket (a dangerous weed).
81 Tomato Leaf Spot.
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83 Key to Orthoptera of Michigan.
84 Strawberry Culture.
90 Special Report of the Upper Peninsula Experiment Station.
91 Some General Information on Lime and Its Uses and Functions in Soils.
94 The Financial History of a Twelve-Year-Old Peach Orchard.
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108 The Robust Bean.

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119 The Septic Tank and Sub-Surface Tile Sewage Disposal System.
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123 Second Growth Hardwood Forests.
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125 Michigan Potato Diseases.
126 An Analysis of the Peach Variety Question in Michigan.
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Circular Bulletins—

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55 Lime Requirement for St. Joseph County.

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13 Oat Smut and Its Control.
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58 The Occurrence of Protozoa in Plants Affected with Mosaic and Related Diseases.
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63 A Study of the Early Blight Fungus, Cercospora Apii Fres.
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65 Studies on a Non-Virulent Living Culture of Bact. Abortus Towards Protective Vacinnation of Cattle Against Bovine Infectious Abortus (Bang's Abortion Disease).
66 The Significance of Bacterium Abortus Antibodies (Agglutinins and Complement-fixing) Found in the Sera of Calves at Birth or After Nursing.
67 Investigations on the Blackleg Disease of Potato.
68 Bacterium Pullorum.
69 The Fruiting Habits and Pruning of the Concord Grape.
70 The Nutrient Requirements of the Strawberry.
71 Growth of Lettuce as Influenced by Reaction of Culture Medium.
72 Adsorption by Activated Sugar Charcoal.
73 Potato Spraying and Dusting Experiments in Michigan.

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The Quarterly bulletin contains contributions by all sections of the Experiment Station. It is issued during February, May, August and November of each year. Copies are sent to the entire mailing list. The Quarterly also contains a list of available bulletins.

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AGRICULTURAL EXPERIMENT STATION

MICHIGAN STATE COLLEGE
Of Agriculture and Applied Science

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CONTENTS

EDITED BY
R. S. SHAW AND E. B. HILL

CONTRIBUTIONS BY ALL SECTIONS OF THE
AGRICULTURAL EXPERIMENT STATION

MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN
Vol. 8, No. 4, May, 1926

INDEX FOR QUARTERLY BULLETINS, 1924 TO 1926

A Classified List of the Articles to be Found in Volumes VII and VIII of the Quarterly Bulletin—covering the period, August 1924 to May 1926.

A great wealth of information is to be found in the past numbers of the Michigan Quarterly Bulletin. This information is for the most part based on the research work of this station either at East Lansing or at other parts of the state and it should be of value to many people in the state. A large number of people write to the College or Experiment Station for information which could be found readily in the earlier issues of the Quarterly.

To secure the greatest service from this publication, all copies should be saved and then referred to as the need arises. To aid the reader in finding quickly the desired information, this and previous indexes have been prepared. The index for the first four volumes of the Quarterly is in Vol. IV, No. 4. The index for volumes V and VI is in Vol. VI, No. 4. The index for the last two volumes, VII and VIII, is in this issue, Vol. VIII, No. 4.

Many of the earlier numbers of this bulletin are still available for distribution. Copies may be secured free of charge upon request to R. S. Shaw, Director, East Lansing, Michigan.

NEW SPECIAL BULLETINS

Special No. 149—Eighty Winters in Michigan Orchards.
Special No. 150—Emergency Hay and Pasture Crops.
Special No. 151—Buckwheat in Michigan.
Special No. 152—Sweet Clover.
Special No. 153—Peppermint Growing in Michigan.
Special No. 154—Hardy Shrubs for Landscape Planting in Michigan.

Copies may be secured free upon request to R. S. Shaw, Director, East Lansing, Michigan.

HAYING TIME

Better Methods Cut Haying Costs and Produce a Better Product

C. R. MEGEE, FARM CROPS SECTION

The feeding value, marketability and cost of production of hay are materially influenced by the time of cutting and method of curing. About two-thirds of the food value of the hay crop is in the leaves and only one-third in the stems. When hay is cut too late or when improperly cured, the leaves shatter off and an inferior quality of hay of low feeding value as well as of low marketability is secured.

By the use of the left-hand side delivery hay rake and the hay loader and raking at the proper time, the haying costs may be materially reduced.

Fig. 1.—The left-hand side delivery hay rake reduces hand labor and a bright, leafy, high quality hay is usually secured when it is raked within two or three hours after cutting.

Mr. R. S. Hudson of the Farm and Horse Department, M. S. C. found the cost of curing hay by this method to be 40 per cent less than by the cocking method. When rather small acreages are to be harvested, the purchase of additional machinery may not be warranted.

Ordinarily the various leguminous crops such as alfalfa, clover, and sweet clover should not be cut at the same stage of maturity. The best quality of alfalfa hay is secured if the crop is cut when the shoots at the crown are from one to two inches long or when the plants are one-tenth to three-fourths in bloom. Since all strains of alfalfa do not bloom alike the shoots and

general condition of the crop should be watched. Cutting earlier than this over a period of years will tend to reduce the stand while the hay from cuttings made later is harsh and brittle and of lower feed and market value.

The best quality of clover hay may be secured by cutting in full bloom or when a few of the heads are turning brown. If the second crop of clover is to be harvested for seed the heads should not be allowed to turn brown since this weakens the plants and fails to control the clover midge.

Sweet clover should be cut for hay before the bloom shows and while the buds are forming. If the plants are allowed to come into bloom, the hay is coarse. In harvesting sweet clover for hay it is desirable to leave a few of the leaves attached to the stubble in order that the second crop may develop. The mower bar should ordinarily be set at a height of six or seven inches above the ground to accomplish this.

The development of a system of curing alfalfa hay by the use of the left-hand side delivery hay rake and the hay loader has eliminated much of the worry experienced in hay harvesting. If a properly constructed side delivery rake is used and the hay raked soon after cutting (within two hours, ordinarily) it will be possible to place the hay in a loose windrow with the leaves toward the center and the majority of stems exposed to the air. To secure a hay that retains its leaves as well as its palatability and aroma, it is necessary that the stems and leaves cure out in about the same time. To facilitate curing, and to dry after rains, the windrows may be turned with the side delivery rake. If the hay is allowed to remain in the swath for any length of time, the leaves are exposed and a majority of the stems covered. If it is left in this condition very long the leaves will wither and die, the stems will remain green and when the hay is handled the leaves will shatter badly, resulting in a coarse hay of low quality.

Hay properly cured in the windrow may be loaded with the hay loader with practically no loss of leaf. It will also retain its leaves much better when handled in the barn during the winter.

MONROE CORN BORER SUBSTATION

The State Board of Agriculture has authorized the Director of the Michigan Agricultural Experiment Station to co-operate with the Bureau of Entomology of the United States Department of Agriculture in establishing a research station for the purpose of investigating methods of controlling the corn borer.

On April 1, suitable land and buildings were rented seven and one-half miles west of Monroe, in a region infested with the corn borer.

The departments of Entomology and Farm Crops are planning for a series of methods of planting and harvesting the corn crop and also for co-operative tests of varieties and for corn breeding work to determine effective control methods. A resident agronomist will be in charge of this work. The Bureau of Entomology, U. S. D. A., will place an entomologist and necessary assistants at the station for the purpose of breeding parasites and conducting entomological research.

MORE ALFALFA

The Production of this Valuable Legume is One Form of Effective Farm Relief

J. F. COX, FARM CROPS SECTION

The production of surpluses of some of our leading staple crops has been largely responsible for the low prices which have commonly prevailed for staple agricultural products during the past six years. One effective way of meeting this condition is to grow crops, wherever possible, which are not likely to meet a glutted market.

Alfalfa is one of the outstanding crops which can be effectively increased in Michigan with very remote possibilities of meeting surplus conditions and with the added benefit of replacing large acreages devoted to less paying crops.

There is very little possibility of a surplus of alfalfa being produced for a number of years. Over two million acres of land in the west, which once produced alfalfa hay for marketing in the east, can no longer effectively grow alfalfa hay for shipment because of the increase in freight rates which took place immediately after the war. Effective alfalfa hay production, therefore, moved nearer to eastern markets. Though the alfalfa acreage has increased rather rapidly east of the Mississippi, there is still room for a million and a half more acres before there is any strong likelihood of a glutted market for this high protein feed.

Growing alfalfa is followed by greater diversification in production; more livestock of all kinds can be carried, and fed more cheaply and efficiently. By proper diversification, Michigan farmers are able to put themselves in a better condition to meet the surplus situation that frequently exists with the grain crops. Alfalfa is widely adaptable and can be grown on the great majority of Michigan soils. The introduction of alfalfa on farms where it is not now grown and a reasonable increase of alfalfa acreage on most Michigan farms, will go far in bettering our agricultural condition at the present time.

On April 26, President Coolidge signed the bill requiring the staining of all imported alfalfa and clover seed in such a way as to designate its source. This law goes into effect 30 days after date of receiving the President's signature. There will be much less likelihood, therefore, of farmers unknowingly receiving Argentine seed or Mediterranean alfalfa seed or other unadapted imported seed, since such seed will carry a distinctive color in the future. Desirable Canadian seed will also be colored in such a way as to identify it.

The production of Grimm alfalfa, and hardy common alfalfa of the northwest has greatly increased and the production, also, of dependable seed particularly Hardigan in our own state is on the increase. With dependable seed available in quantity, Michigan farmers can plant alfalfa, provided the soil is limed where lime is needed and the seed is planted on a firm seed bed, with assurance that it is one of the most dependable hay and pasture crops now being planted in the state.

HOGGING DOWN CORN*

Hogs make Rapid Gains and Return a High Value for the Corn Consumed

W. E. J. EDWARDS AND G. A. BROWN, ANIMAL HUSBANDRY SECTION

The practice of hogging down corn is gaining in many of the leading corn-producing sections, especially where the corn stalks are not needed for feeding other classes of live stock. Among the advantages of this system of feeding are the saving of considerable labor in harvesting and feeding the crop and in the work of hauling and spreading manure.

During a wet fall, especially if the soil is rather heavy, hogging down corn is not so satisfactory as during dry weather, although there are many feeders who regularly follow the practice of hogging down a considerable acreage each year.

Hogging down corn is largely a fattening process. Pigs that are well enough grown to be finished in the corn field fit well into this practice. Though fattening pigs require considerably less protein than do growing pigs, they will not make the maximum or most economical gains without a satisfactory supply of suitable protein in the ration.

In order to ascertain whether it is advisable to purchase the protein needed, as tankage, or grow it in the form of rape or soybeans, an experiment was conducted at this Station during the season of 1925.

Three lots of one acre each were planted with Picket's yellow dent corn May 25, using between eight and nine pounds of seed per acre. Lot I was also sown with Dwarf Essex rape at the rate of eight pounds per acre immediately after the last cultivation of the corn. Lot II was planted with Manchu soybeans at the rate of nine and one-half pounds per acre immediately after the corn was sown. No other feed except minerals was given the pigs in these two lots. The pigs in lot III had access at all times to 60 per cent tankage in a self-feeder as well as to the mineral mixture.

A separate attachment may be obtained for the corn planter for planting the soybeans or the soybeans may be added to the corn at short intervals. The latter method gives a fairly uniform stand if precautions are taken to mix the soybeans and corn often.

Early maturing varieties of corn and soybeans are advisable in order that the pigs may be turned in the field early enough in the fall to harvest the crop before the usual disagreeable weather of late fall.

Each group of pigs had access to a mineral mixture consisting of 45 pounds steamed bone-meal, 20 pounds finely ground limestone and 30 pounds of common salt, placed in a self-feeder.

Water was available at all times in an automatic waterer placed in each lot.

Conditions were fairly favorable for the development of the corn crop.

*Warning Note: According to our present knowledge on the subject, hogging down corn should not be practiced in the districts infested with corn borer.

The yield of Lot I was 42.86 bushels, Lot II 33.96 bushels and Lot III 32.57 bushels per acre. The yield was calculated on a 15.5 per cent moisture basis after husking, weighing and analyzing two representative rows of corn from each lot.

There was a thick stand of rape from eight to ten inches high in Lot I when the pigs were turned in; a considerable amount of rape left in this lot at the close of the experiment.

The stand of soybeans in Lot II, though not heavy, appeared sufficient for the pigs as there were a few soybeans left after the corn had been consumed.

Most of the corn in the different lots and the soybeans in Lot II were well glazed when the pigs were turned in their respective lots.

Seven pigs averaging approximately 149 pounds each were put in each lot October 4.

More detailed information of the experiment is given in Table 1.

Table 1.—Results of hogging down corn in 1925.

7 Pigs in each lot	Lot I	Lot II	Lot III
	Standing corn rape minerals self-fed	Standing corn standing soy-beans minerals self-fed	Standing corn tankage minerals self-fed
Area of lot	1 Acre	1 Acre	1 Acre
Yield of corn[1]	42.86 bus.	33.96 bus.	32.57 bus.
Feeding period	Oct. 4—Nov. 7 34 days	Oct. 4—Nov. 3 30 days	Oct. 4—Nov. 7 34 days
Average initial weight (lbs)	149.00	149.14	149.29
Average final weight (lbs.)	204.38	200.86	203.88
Total gains made on one acre	387.66	362.00	350.33
Average daily gain (lbs.)	1.629	1.724	1.510[2]
Average daily feed consumed (lbs.):			
Corn	10 164	9.148	7.944
Tankage	....	....	.194
Minerals	.011	.038	.006
Total	10.175	9.186	8.144
Feed required for 100 lbs. gain (lbs.):			
Corn	624 00	530.66	526.08
Tankage	....	....	12 84
Minerals	.709	2.21	.425
Total	624.71	532.87	539.35
Value of gains produced at $10.76 per 100 lbs.[3]	$41 69	$38.93	$37.68
Value of tankage[4]	....	....	1.58
Value of gains produced by one acre of standing crops	41 69	38.93	36.10
Value returned by hogs for each bushed of corn	.97	1.13	1.10

[1]Calculated on a 15.5 percent moisture basis after husking, weighing, and analyzing two representative rows of corn from each lot. This corn was fed back to the pigs in the lots from which it was taken.

[2]One pig in Lot III died Nov. 1, weight 172 pounds.

[3]Price received after deducting shrinkage, shipping and selling charges.

[4]Price of tankage, $70.00 per ton.

Summary

1. The soybean lot fed 7 fattening pigs 30 days; the rape and tankage lots each fed the same number of similar pigs 34 days.

2. The pigs in each lot made very satisfactory daily gains. Though there was no wide difference, the soybean lot made slightly the most rapid gains, with the rape lot coming next in order.

3. The lots fed tankage and soybeans, respectively, required practically the same amount of feed to produce 100 pounds of gain. The lot fed rape required considerable more feed for the gains made.

4. In previous experiments conducted at this Station the lot fed tankage made the most rapid gains and also required less feed for 100 pounds gain than did either the rape or soybean lots.

5. While the yield of corn was in no case out of the ordinary, each lot returned a high value in the pork produced.

6. The values returned by the hogs for each bushel of corn consumed were as follows: Soybean lot $1.13, tankage lot $1.10 and rape lot $0.97. In addition to the labor saved in harvesting and feeding the corn, these values, especially in the case of the soybean and tankage lots, were considerably above the market price and demonstrate that hogging down corn is a rapid and economical method of converting this crop into pork.

SWEET CLOVER

Special Bulletin No. 152, by C. R. Megee, contains the latest information on the growing of sweet clover in Michigan. The salient points of the summary are as follows:

"Sweet Clover is a profitable pasture crop. It is very valuable as a soil builder. When cut at the proper stage, the feeding value of sweet clover hay compares favorably with alfalfa and red clover hay. Satisfactory yields are seldom secured on acid soils. Inoculation is advisable. Sweet clover should be seeded in the early spring on a well compacted seed bed. It should be cut for hay at a height of six to eight inches above the ground just before the blossom buds appear. The hay should be carefully cured. Harvest sweet clover for seed when sixty to seventy-five per cent of the seed pods have turned brown."

Ordinarily, sweet clover may be seeded until August 10 to 15. If seeded later than this date, it is likely to suffer from winter killing. Summer seedings do not usually produce hay or pasture the first season but should provide an abundant crop the second season.

"As a pasture crop, sweet clover is rapidly gaining in favor in all sections of the state. Especially is this true in the dairy districts. The carrying capacity varies with the season and with the soil, but as a rule, it may be expected to accommodate about one head of cattle per acre throughout the growing season. Under very favorable conditions, three or four head of livestock may be pastured on one acre."

A copy of this bulletin may be secured free upon request to R. S. Shaw, Director, East Lansing, Michigan.

DEPRAVED APPETITE IN DAIRY CATTLE

Results Indicate that a Phosphorous Deficient Ration is the Primary Cause of this Trouble

C. F. HUFFMAN AND GEORGE E. TAYLOR, DAIRY SECTION

Depraved appetite in dairy cattle is fairly common in certain sections of Michigan. Growing animals as well as cows in milk are afflicted by this disturbance. Farmers in general are unable to determine the underlying causes of this disorder and in the majority of cases are at a loss to know how to treat animals suffering from it.

Depraved, or perverted appetite, is manifested by the eating of materials that cannot ordinarily be classed as food, such as bone, wood, hair, sticks, bark of trees, dirt and manure. Though the eating of such material is not

Fig. 2.—Heifer C-16 eating manure.

ordinarily harmful in itself, bones and sticks or hair balls not uncommonly lodge in the throat or in the digestive tract and unless they are removed may result in the death of the animals. The real detrimental effects, however, lie in the physiological disturbances accompanying depraved appetite. The animals affected present a very unthrifty condition and in some cases the joints become swollen and stiff and the animals appear lame when moving about. There is a general loss of flesh and the coat of hair becomes coarse and rough. Growing animals suffer a cessation of growth in addition to the general unthrifty condition. Cows in milk present the same unthrifty

condition and in addition suffer a decrease in milk production that is usually proportionate to the severity of the attack. In extreme cases general emaciation develops and death may follow unless the animals are properly treated.

This abnormal craving is caused by some deficiency in the ration. The primary cause of depraved appetite has been attributed by a number of authorities to a lack of sufficient minerals in the ration, particularly a deficiency of phosphorous. Our observations tend to substantiate this theory.

Depraved appetite is frequently manifested by animals under experimental conditions fed on ratons deficient in quantity and quality of roughage. These animals crib and chew their mangers and stalls, eat straps, sacks and shavings or any other material that happens to come within their reach. When turned into the exercise lot they resort to eating manure or chewing the hair off the bodies of other animals. Figure 2 shows a picture of heifer C-16 eating manure. Figure 3 shows a picture of two hair balls that were regurgitated

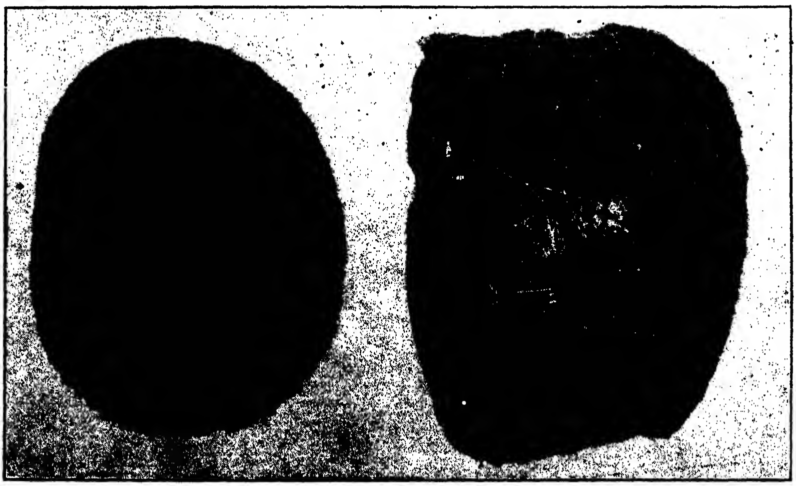

Fig. 3.—Picture of hair balls regurgitated by calf C-22. This animal had an intense craving for hair.

by calf C-22. These hair balls are formed by the churning or ruminating movement of the first stomach. It became necessary to muzzle calf C-22 in order to prevent her from eating hair from the bodies of other animals. On one occasion this heifer ate the switches from the tails of three different animals in one day. She is now 26 months old and her rumen is so full of hair balls that they may be felt upon external examination on her left side.

The feeding of different mineral supplements in addition to restricted rations is not a definite cure for depraved appetite in all cases. For example, syrup of iron phosphate relieved the depraved appetite in some instances, but when fed to other animals suffering from the same disturbance failed to relieve the condition. Well cured green alfalfa hay, added as a supplement to the restricted ration, has effected a cure in all cases tried. This indicates that some factor in alfalfa hay prevents and cures depraved appetite as it occurs under experimental conditions. However, a mineral mixture similar to the mineral combination found in alfalfa hay failed to relieve the de-

praved appetite. These results, however, cannot be compared to conditions found under ordinary farm conditions where a phosphorous deficiency is the usual cause of depraved appetite.

Where depraved appetite occurred under farm conditions the farmers were feeding very little or no grain in the ration as a supplement to the roughage. Concentrates are relatively high in phosphorus and the roughages are relatively low in this element. In certain sections the disturbance seems to be more prevalent during the summer than during the winter months. During the summer season particularly, farmers feed very little or no grain; therefore, if depraved appetite is caused by a phosphorous deficiency manifestations should be more prevalent at this time. The phosphorous requirement of dairy animals, especially cows in milk, is relatively high. Hence animals fed on roughages alone or on a ration deficient in phosphorous do not get enough from the ration to meet the body requirement. In sections

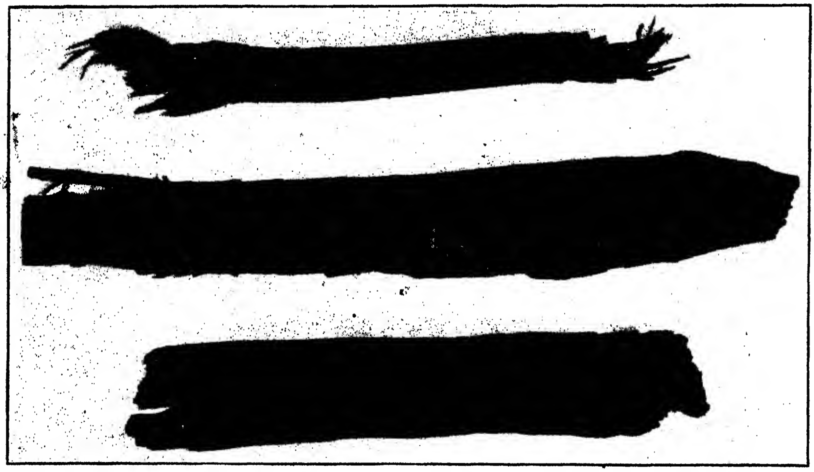

Fig. 4.—Sticks collected from pasture where animals suffering from depraved appetite had been grazing. Note chewed areas and frayed ends.

where depraved appetite occurs, farmers feeding bran, cottonseed meal or linseed oil meal in addition to a grain mixture and a good quality of roughage are having no trouble with their cattle from this disturbance.

Depraved appetite as found in the Thumb region was first called to our attention by J. W. Sims, County Agricultural Agent of Tuscola County. Through the co-operation of Mr. Sims it was possible for us to visit this section and to make a study of the soil and feeding conditions on the farms where depraved appetite occurs rather frequently. The cows on some farms had cribbed their mangers and stalls in the barns and when they were turned out to pasture resorted to chewing bones and sticks. Figure 4 is a picture of three sticks that were collected from a pasture where animals suffering from depraved appetite had been grazing.

Soil samples taken on these farms were found to contain only approximately one-half as much phosphorous as was found in the soil on farms where depraved appetite has never occurred. Three samples of forage were col-

lected for analysis, one in the early spring, one in mid-summer and the third in the early fall as the condition appeared to be worse during the early spring and gradually abated during the fall. All of the analytical work was conducted by the Chemical Section of this Station.

The results of this investigation are shown in Table 1.

Table 1.—The analysis of grass collected during the pasture season on areas where depraved appetite occurs.

Pasture	Analysis of Grass (air dry)	
	Calcium, per cent.	Phosphorous, per cent.
Early Spring	0.6437	0.5333
Mid summer	0.4556	0.7354
Early fall	0.3704	0.8955

Table 1 points to a phosphorous deficiency as the primary cause of the depraved appetite, since this condition gradually abated as the phosphorous content of the pasture increased. This increase of phosphorous in the pasture was accompanied by the development of seed in mid summer and early fall.

The farmers in this section co-operated with the Experiment Station and treated the herds affected in accordance with our directions. A mixture of one part salt and two parts of especially steamed bone meal was placed before the animals where they could have ready access to it at all times. The depraved appetite, or abnormal craving for bones and wood, disappeared in a short time. The breeders in this section are now able to control the disturbance by feeding this mixture. This same treatment has been given a trial on a number of farms in other sections of the state. Favorable results have been reported in these cases.

Summary

As a means of controlling depraved appetite as it occurs, it should be kept in mind that, under farm conditions where a good grain mixture is included in the ration the possibility of the occurrence of depraved appetite is minimized. Besides receiving an adequate grain ration, particularly during the summer months, the animals should have access at all times to a mixture of one part common salt and two parts steamed bone meal. When this mixture is first fed the animals may consume considerable quantities. However, it is harmless and the animals will not consume more than they need. As soon as the animals' requirement for phosphorous has been satisfied they will consume only moderate amounts. Caution should be taken in selecting the quality of steamed bone meal used. The bone meal should be finely ground and comparatively free from odor, else it may be impossible to induce the animals to eat the mixture. The salt and bone meal should be fed under an open shed or where it will have protection from the weather; otherwise the rain will cause considerable loss by leaching away the salt.

FEEDING FOR EGGS

Increased Production per Hen Reduces Egg Cost at the Michigan Egg Laying Contest—Rations supplemented by Cod Liver Oil get results

C. M. FERGUSON, POULTRY SECTION

In the May Quarterly Bulletin for 1925 we published a summary of the cost of producing winter eggs at the egg laying contest plant during the winter of 1924-1925. The feeding practice used at plant is designed to get maximum production without breaking down the vitality and resistance of the bird. To attain this end we have gradually modified our feeding practice. The general trend has been toward the feeding of more grain and the addition of milk to the ration. We found as these changes were made

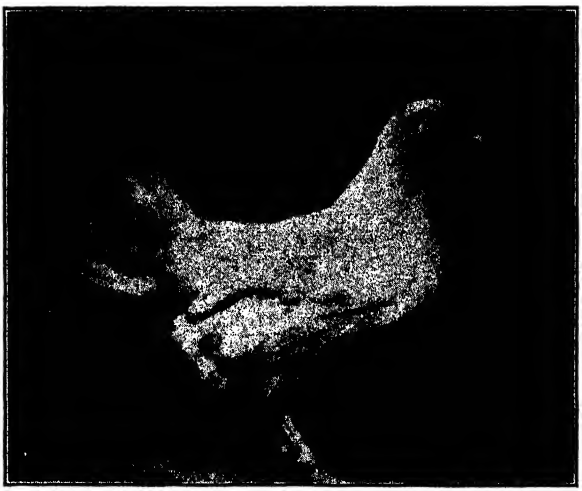

Fig. 5.—High Hen 1924 and 1925, a White Leghorn entered by Seidel and Buren of Toledo, Ohio; Record 308 eggs.

that we were able to keep the birds in better physical condition but we were unable to cope with a condition causing leg weakness among the laying pullets. In November of this year we again modified our ration adding cod liver oil and more green feed. The results have been even better than we anticipated. Production as shown in Table 1 is greatly above that of former years.

Just how much of this increase can be attributed directly to feeding is very difficult to ascertain. There is no doubt that the stock coming in each

Table 1.—Winter production—four years.

	Average production per hen, eggs.	High pens—(The number of eggs from 10 hens).			
		Rock	Reds	Leghorns	Anconas
November 1 to February 27, 1923	41.4	612	480	685	408
November 1 to February 27, 1924	48.7	630	684	846	632
November 1 to February 27, 1925	48.3	758	792	734	503
November 1 to February 27, 1926	59.9	797	701	963	520

year is of superior breeding and some of the increase must also be attributed to the excellent health of the birds this winter. We believe the cod liver oil has a direct bearing on this factor which is of paramount importance in getting heavy yields. Only vigorous hens will give best results. Leg weakness has been practically under control, only two or three cases have appeared. The strength and texture of the shells have been much better than in previous years and the percentage of blood spots in eggs materially reduced. These conditions usually accompany heavy production and seem to have been practically controlled by the addition of cod liver oil to the ration. The cost of the oil fed at the rate of 1 pound to 16 pounds of condensed milk was slightly over 3½ cents per hen for the winter period, increasing the feed cost per hen only 2 per cent.

The Contest Ration

Scratch Feed:

100 lbs. cracked corn
100 lbs. whole wheat

Mash:

150 lbs. ground corn
100 lbs. ground oats
100 lbs. bran
100 lbs. flour middlings
50 lbs. meat scrap
50 lbs. alfalfa meal
5 lbs. salt
15 lbs. ground limestone

Green Feed: Sprouted oats.

Milk: Condensed buttermilk with 6 per cent cod liver oil added.

Grit: Oyster shell and charcoal always available.

Winter Feeding Method

The method of feeding followed at the contest plant is as follows:

5 A. M.—Lights turned on.
Birds watered and given a light feed of sprouted oats.
A light feed of grain is given in a deep litter.
9 A. M.—Green feed—sprouted oats.
11 A. M.—Condensed buttermilk.
4:30 P. M.—Heavy feed of scratch grani.

Dry mash before birds at all times.
Grit shell and charcoal in hoppers.

Amount and Cost of Feed

Table 2 gives some interesting data on the amount and cost of feed per hen for the four winter months.

Table 2.—Feed consumption and cost by breeds—November 1, (1925) to February 28, (1926)

	No. pens.	Lbs. grain per hen.	Lbs. mash per hen.	Lbs. milk per hen.	Lbs. cod liver oil per hen.	Lbs. oats per hen.	Av. feed cost per hen.	Av. eggs per hen.	Av. cost per dozen.	Av. net profit per hen.
Leghorns	63	13.9	10.34	3.8	.23	3.92	$0.77	62 47	$.1286	$1.64
Rocks	19	17 8	11.3	4.68	.29	3.92	.91	58.47	.1885	1.24
Anconas	3	11 3	7.97	3.8	.23	3 92	.65	41 2	.1918	.86
Reds	13	17 5	12.1	4.8	.30	3 92	.93	56 0	.2004	1.13
Wyandottes	1	16.6	9.4	4.8	.3	3 92	.85	39 9	.2556	.62
Barnevelders	1	16 9	9.7	4.8	.3	3.92	.86	52 2	.1976	1.07
All Breeds	100	15.17	10.71	4.05	.29	3 92	.82	60.13	.1635	1.40

The Leghorns proved to be the most economical producers of eggs consuming less feed and having a higher production than the heavy breeds. The cost of producing eggs in this group stayed at 12 cents per dozen. It must be remembered that this figure includes feed only. No labor, depreciation or interest is figured.

The ratio of grain to mash for the entire contest was 1:0.7. This ratio was not maintained throughout the season. In November the grain consumption was considerably lower. This method hurried the pullets into production and the grain was increased as production picked up. They have been fed just as much grain as they would clean up. Their appetites have remained good and they have continued in excellent flesh. Care has been exercised in feeding to prevent the birds going off feed. This must be carefully watched.

No effort was made to figure the difference in sales value of eggs from the various breeds. The price of 44.35 cents per dozen was the average all eggs sold regardless of grade, from November 1 to February 27.

A statement of the price range by weeks follows:

November, 1st week..................	$0.53
November, 2nd week.................	0.54
November, 3rd week..................	$.58
November, 4th week..................	0.53
December, 1st week..................	0.49
December, 2nd week.................	0.47
December, 3rd week..................	0.46
December, 4th week..................	0.41
January, 1st week....................	0.42
January, 2nd week....................	0.40
January, 3rd week....................	0.42
January, 4th week....................	0.37
February, 1st week....................	0.36
February, 2nd week..................	0.36
February, 3rd week	0.35
February, 4th week..................	0.36

Summer Suggestions

Following a winter of heavy production, the birds require careful attention during the spring and summer months. The contest hens are turned out just as soon as possible and the artificial lights are turned off, reducing gradually the length of working day by 15 minutes a week, until sunrise comes at the same time at which the lights are turned on.

When warm weather arrives, the birds require a smaller amount of the carbonaceous feeds such as corn and wheat. We reduce the corn in the laying mash from 150 pounds to 100 pounds and gradually reduce the amount of scratch feed in order to increase the mash consumed. More green feed is supplied and with the advance of summer it is supplied from various sources such as rape, alfalfa, Chinese cabbage, etc. As soon as hot weather starts in June, we start feeding a wet mash, using the mixture suggested above, moistening it with condensed buttermilk diluted with water. This induces the birds to consume more mash and aids in preventing early moult.

Fresh, clean water is highly important. The drinking dishes should be cleaned daily and filled with fresh water.

Birds affected with lice and mites will not be thrifty or productive. We follow the practice of treating the birds for lice before turning them out in the spring. Sodium fluoride is an excellent insecticide for this purpose. Apply it sparingly in the fluff and body feathers. A second application may be necessary in about ten days in cases of severe infestation.

Mites are migratory, spending only a part of their life cycle on the body of the host. They can be best controlled with applications of waste motor oil or carbolineum. Nests and roosts should be given a thorough application early in the season to prevent the appearance of this parasite.

CUTHBERT RASPBERRY STOCK

A Comparison of the yields from Stock from Eastern and Southwestern Michigan

STANLEY JOHNSTON, HORTICULTURAL SECTION

The occasional appearance of distinct sports or strains of old varieties has always been a matter of interest to fruit growers and recently much attention has been given to them. "Improved" strains of a number of varieties of fruits are listed by nurseries. Whenever or wherever stock of any variety does particularly well the question is almost sure to arise "Is this high degree of perfection due to sporting—to the appearance of a new strain"? This question has been raised in connection with the reputed superiority of the Cuthbert raspberry as grown in the Thumb district of eastern Michigan.

In order to answer this specific question about the Cuthbert raspberry, a planting was made at the South Haven Experiment Station in the spring of 1922 in which stock of this variety from an exceptionally good field in the Thumb district was set in rows adjacent to stock obtained from southwestern Michigan. Six hundred feet of row were set with stock from each source. The rows were six feet apart and the plants were four feet apart in the row. Soil conditions were uniform and both series of plants received the same cultural treatments. Notes on shoot and cane growth were made from time to time and each year fruiting records were obtained.

The casual observer would recognize no differences between the two lots of plants; in fact there were no significant differences in yield in any of the three fruiting seasons (1923-1925) for which records are available. Detailed records were obtained in 1925 from 48 feet of row selected as a sample from each of the two lots. Those selected strips were representative of the two lots of plants and strictly comparable. Table 1 summarizes the data obtained. Clearly the differences between the two lots are well within the limits of experimental error and not significant. Observations on the color and quality of the fruit failed to show any difference. Had the berries from the two different series of plants been mixed it would have been impossible to separate them.

Table 1.—Fruiting records of representative plants, 1925

Plants from	Row length	No. canes	Total wt. of fruit	Total no. berries	Av. cane diameter	Av. size berry
Eastern Michigan	48 ft.	107	15 lbs. 15 oz.	6621	.297 in.	.038 oz.
S. W. Michigan	48 ft.	104	16 lbs.	7278	.315 in.	.035 oz.

If the Cuthbert raspberry as grown in the Thumb District of Eastern Michigan is superior to Cuthbert as grown elsewhere in the state, it is either

because soil and climatic conditions are more favorable or because better cultural methods are practiced. There is no evidence that it is due to a difference in strain of plants. This, however, should not be interpreted as meaning that no importance should be attributed to the use of selected or improved strains in other fruit crops. Moreover, there was no evidence of any place-effect influence, such as there often is in the case of potatoes. That is, nothing is likely to be gained by securing raspberry stock from exceptionally heavy producing plantations that are heavy producers because of favorable climate or soil. The important thing is to secure stock that is reasonably vigorous and free from disease.

ARSENICAL INJURY TO PEACH

The Most Noticeable Injury is Often Observed after the Middle of the Summer

C. W. BENNETT, BOTANICAL SECTION

During the last three years many peach growers in Michigan have had experience with a spray injury which has caused a decided shock to affected trees and greatly reduced the usefulness of a number of orchards. Two young orchards in the southwestern part of the state were so badly injured in 1925 that the owners were intending to dig out the affected trees and replant in 1926. Several older orchards were considerably injured, and many orchards sprayed with arsenicals showed traces of burning of different types.

The most noticeable injury due to arsenicals, often comes after the middle of the summer. Attention may be called to the trouble first by the unhealthy appearance of twigs scattered through a tree. The leaves on certain of the new shoots may begin to droop, roll and turn yellow and may later fall. If such twigs are examined more closely, it will be found that there is a dark reddish colored canker at the base of the new growth. This discolored area at first extends only a part of the distance through the bark, but may later discolor the inner bark and other tissue and kill the twig. In some of the twigs other injured areas may occur. These are usually located around the buds, and appear as dark spots often about a quarter of an inch long. These spots sometimes kill the buds and the injured surface frequently cracks and gum flow follows. Gum is often found in abundance also on the canker at the base of the new growth. Dark spots around the buds of the young shoots are very common on peach trees interplanted with apples. In spraying the apple trees some of the spray mixture containing arsenicals finds its way to the peach limbs, adheres in greatest quantity around the buds and causes the death of the outer bark.

Injury, however, is not confined to young growth. Decided cankers are produced on the one and two-year-old limbs. These are of a darker reddish color and at first are smooth, but soon the bark begins to crack around the edge and over the surface of the injured spots, finally leading to the pro-

duction of a very rough surface on the limb. In the more severe types the bark cracks and there is considerable gum flow. Older limbs may be very much weakened by injury of this kind.

Leaves also are sometimes directly injured by spray containing lead arsenate. Brown spots a quarter of an inch or less in diameter appear; these die and pull away from the surrounding leaf tissue and drop out, leaving a "shot hole" condition. Such leaves in many cases turn yellow and drop.

The fruit is not often injured by contact with spray but brown spots may be found around the base of the fruit attachment. In such cases the peaches are smaller and have a very poor flavor.

The vigor and rate of growth of trees make a very great difference in their susceptibility to injury. Trees making a weak growth are much more likely

Fig. 6.—Different degrees of arsenical injury. Reading from left to right, the first twig shows injury at the base of the spring growth. Note the gum which has exuded from the injured surface. Injury is shown also on the second year growth. The second, third and fourth specimens show different types of injury; the fifth came from an unsprayed tree and is normal.

to be damaged than are vigorous individuals. The same spray which causes severe damage to a weak one may have very little injurious effect on a thrifty one. Cases are frequently observed in which a limb on an otherwise vigorously growing tree, has been weakened by a brown rot or a frost canker. Such limbs may show severe arsenical injury and the remainder of the tree almost completely escape.

The reason for the increase in arsenical injury in recent years seems to be due to two factors: First, the more general use of sprays on peaches, and second, to the use of spray materials in which the amount of lime as compared to sulphur has been reduced. The New Jersey and the Pennsylvania stations have found that sprays, self-boiled or the dry-mixed preparations,

having a 16-16-100 (16 pounds of sulphur, 16 pounds of lime, 100 gallons of water) composition, to which arsenate of lead was added in the usual amount, gave little or no injury. On the other hand, arsenate of lead added to a spray of a 16-8-100 (16 pounds of sulphur, 8 pounds of lime, 100 gallons of water) mixture caused considerable damage.

Measures for preventing arsenical injury may be summarized as follows:

1. Do not use an excessive amount of arsenate of lead in spray mixtures.
2. Make sure that all peach sprays in which arsenate of lead is used have as many pounds of lime as of sulphur in 100 gallons of spray. When using a so-called dry-mix of a 16-8-100 composition, if lead arsenate is present in the mixture, add 8 pounds of lime to 100 gallons of spray before applying.
3. Give the orchard the best of care and thus keep the trees vigorous and resistant to injury.

FOREST NURSERY PRACTICE

Proper Density in Seed Bed and Time of Planting are Essential to Success

P. A. HERBERT, FORESTRY SECTION

The growing of forest planting stock requires careful attention to details. Coniferous stock is especially delicate during the first season, requiring almost daily care.

The best soil for the growing of forest tree seedlings is a moist, well-drained sandy loam. Lighter soils are preferable to heavier. Broadleaf seed, such as the oaks, ash, hickory, maple, elm, etc., can be sown directly in drills and usually requires no more attention than any field crop. Coniferous seed, on the other hand, germinates and grows best in boxed beds. These beds are usually 4 x 16 feet with the sides about 6 inches high. The seed is sown broadcast and covered with sterile sand to twice the thickness of the seed. The sterile sand can be procured by taking sand several feet below the surface of a sand hill. This covering will materially reduce the attack of the damping off fungi which are found in every soil. After being sanded the beds are rolled, covered with burlap and kept well watered until the seeds germinate.

As soon as the first seedlings appear, the burlap is removed, the watering reduced, and a half shade created by placing slat frames over the beds. The watering should be so regulated as to keep the surface fairly moist. A wet surface allows the rapid development of damping-off fungi, to which the seedlings are especially susceptible during the first month. The shade cast by the slat frame reduces the amount of moisture necessary and protects the seedlings from constant sunshine. In nature, coniferous seedlings grow in the shade of the mother tree and the system of shading is merely a method of imitating nature. During cloudy or rainy weather the slat frames are taken off and all artificial watering is omitted. Shading and watering are usually necessary only during the first years.

A question that is frequently asked is, "How many seeds should one plant?" The number sown per square foot depends on both the vitality of the seed and the size of the young plants. Ordinarily 150 seedlings per square foot is the maximum number. Spruce is an exception to this rule, as the seedlings are smaller than most others during the first two years, and therefore, 175 can be grown per square foot. Overcrowding materially reduces the size of the seedling. In Fig. 7, No. 3 represents a normal two-

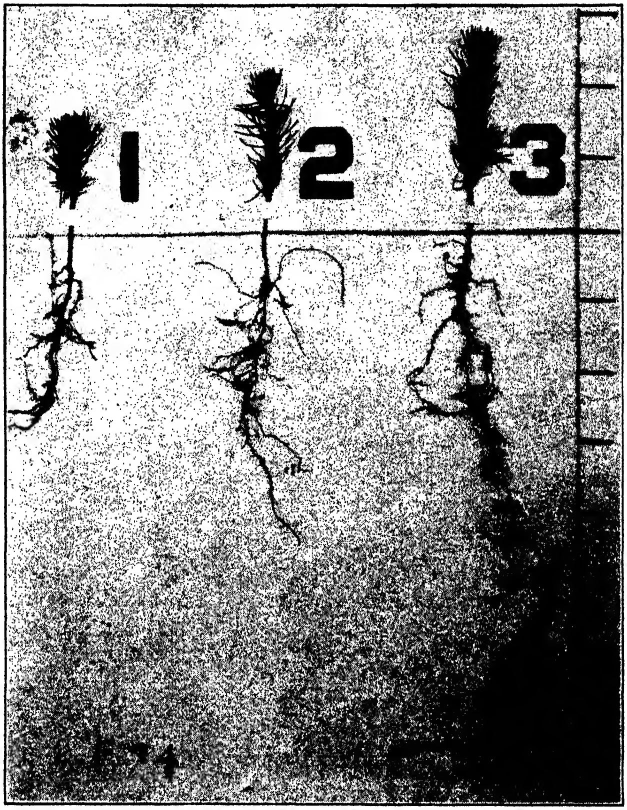

Fig. 7.—Two year old Norway spruce seedlings: (1) seed sown June 24; (2) density 250 seedlings per square foot; (3) normal seedling-density 150 per square foot, seed sown May 10.

year-old Norway spruce seedling approximately 3 inches high that was grown in a bed with a density of 150 per square foot. The next plant (No. 2) represents one grown in a seed bed with a density of 250 seedlings per square foot.

Another question that is frequently asked is, "When should the seed be planted?" Nature usually plants its seed in the fall, and if protection from mice and other seed-eating animals can be secured, this is also the best time for artificial sowing. This is especially true of white pine, which if not

planted until the following spring will germinate irregularly, some of the seed lying over until the following year. Succulent seeds, such as oak, walnut, chestnut, hickory, etc., must either be planted in the fall or stored over winter in a moist condition, by stratifying in moist, sandy soil. Such seeds if stored dry lose their ability to germinate before spring. Because of the difficulty in protecting fall sown seed from rodents, all dry seed species such as spruce, red pine, larch, ash, locust, etc., are usually planted in the spring. The earlier the seed is sown in the spring the better. No. 1 of Fig. 7 shows a two-year-old Norway spruce seedling grown from seed sown on June 24. Number 3 is a normal seedling from seed sown in early May and is almost twice as large.

Table 1 will enable one to determine how many pounds of seed are necessary to produce a specified number of seedlings:

Table 1.—The number per pound and the per cent of germination of seed of the more common species of trees.

Species	No. of seeds per lb.	Germination percent.
Ailanthus	12,700	45
American elm	94,000	32
Balsam fir	44,000	30
Basswood (whitewood)	5,000	2
Beech	1,400	40
Black cherry	4,500	12
Black locust	26,000	52
Black spruce (Shellbark spruce)	500,000	20
Black walnut	25	90
Box elder (Ash-leafed maple)	12,700	2
Chestnut	135	65
Hackberry	2,600	20
Hardy catalpa	19,000	31
Hemlock	175,000	15
Honey locust	2,800	40
Jack pine	80,300	63
Papaw	650	40
Red cedar	17,500	10
Red oak	130	69
Red pine (Norway pine)	65,500	65
Shagbark hickory	90	82
Silver maple	15,000	34
Sugar maple (Hard maple)	7,000	20
Sycamore (Button ball)	168,000	37
Tulip (Poplar)	18,300	1
White oak	200	71
White ash	6,200	10
White birch	710,000	21
White cedar (Arborvitae)	300,000	21
White pine	27,200	32
White spruce (Cat spruce)	250,000	14
Yellow birch	400,000	29

NEW EXTENSION BULLETINS

Extension Bulletin No. 46—Potato Price Trends.
Extension Bulletin No. 47—Buying Fertilizers.
Extension Bulletin No. 48—Poultry Housing.
Club Bulletin No. 17—Dairy Club Work.

Copies may be secured free upon request to R. J. Baldwin, Director, East Lansing, Michigan.

FERTILIZING THE FOREST NURSERY

Poultry and Barnyard Manure are the Most Effective

P. A. HERBERT, FORESTRY SECTION

Trees remove mineral fertility from the soil just as any other plants do. In the woodlot, much of this is returned to the soil by the leaves and smaller branches, and consequently the depletion of the forest soil is exceedingly slow. However, in a forest nursery where trees are grown only for a few years and then removed to make room for others, very little material is returned to the soil; consequently such nursery soil must be replenished by barnyard manure, green manure, or a commercial fertilizer. As very little is known about the specific requirements of forest trees, most forest nurseries keep their soil productive by the use of either barnyard or green manures, both of which not only contain all the mineral elements essential to plant growth but also improve the physical condition of the soil.

Mineral fertilizers, on the other hand, are very useful when barnyard manure is difficult to procure as is often the case in forest regions, or when the nursery site is limited in size where part of the area cannot well be spared for soiling crops. Experiments both here and abroad indicate that on most soils mineral fertilizers increase the size and vigor of forest tree seedlings. This is a distinct advantage in forest planting, as larger stock can withstand drought and other adverse climatic conditions better than smaller stock of the same age. However, painstaking experiments in Europe have shown that the early advantage gained by forest tree seedlings from fertilizer is not maintained in later years. This would indicate that the use of commercial fertilizers in a forest nursery can be justified only by the greater resistance of the trees so grown to adverse site conditions during the period of establishment.

In order to determine the value of various fertilizers in its forest nursery at East Lansing, the Forestry Department laid out 52 fertilizer plots in the spring of 1924. The total amount of fertilizer used and the proportion of the three essential elements to make up this amount in each plot was based largely on the results obtained by other American investigators in this field. Only those combinations were tried that had already been found of value. This can in no sense be considered a duplication of effort, as different soils and different species require different treatment. As a matter of fact, each of the three investigations that this experiment is based on gave entirely different final results.

The seed bed technic used in this experiment did not differ from that ordinarily used in our nursery. The usual boxed seed bed was used and the fertilizer thoroughly mixed with the upper six inches of the soil. The beds were rolled and the seeds broadcasted at the rate of 350 per square foot. They were then covered with 1/4 inch of sterile sand; no other precaution was taken against damping off. The beds were finally covered with burlap for nine days until the first of the seedlings began to appear. A test had

been made previously in the green house and the seed used showed a germinative per cent of 70. The actual tree per cent at the end of the first growing season was 49 per cent which, though somewhat lower than the greenhouse test, is normal for all species, as greenhouse conditions can be more carefully controlled. No damping off occurred in any of the beds, and there was no marked difference in rapidity or amount of germination. Table 1 lists the fertilizer combinations arranged in order of general vigor and growth in the seedlings at the end of the second growing season. The symbol (C-2) (Pa-1), etc., refer to the ranking of this fertilizer in tests carried on by others. C refers to the experiment conducted under Professor S. N. Spring of Cornell University. Minn., refers to those of T. Schantz Hansen at Cloquet Forest Experiment Station, and Pa., refers to those of George A. Retan at the Pennsylvania Forest Academy.

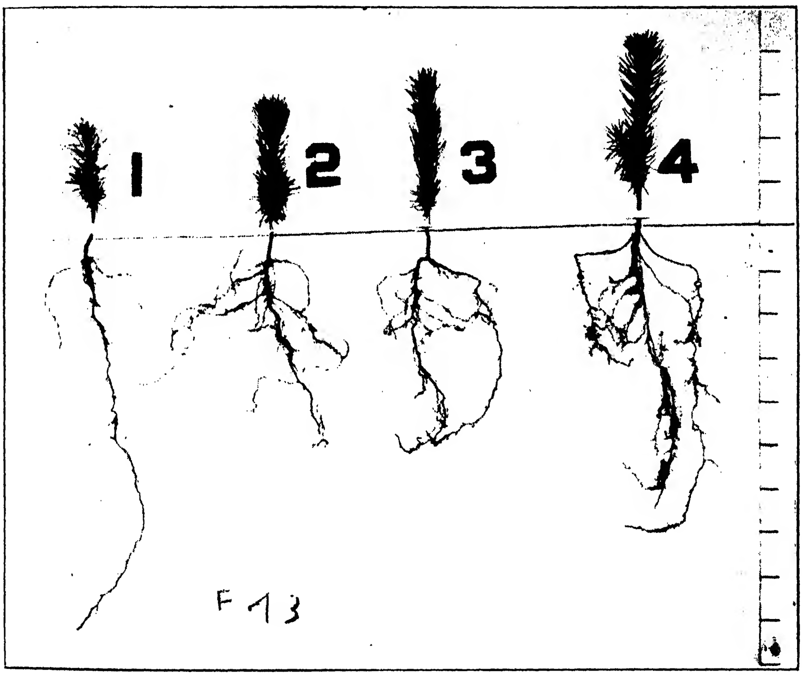

Fig. 8.—Two year old Norway spruce seedlings: (1) check; (2) mineral fertilizer; (3) horse manure; (4) poultry manure.

The accompanying photograph of average plants taken from the three best plots and a plant taken from a check plot for purpose of comparison shows clearly the difference in size and in root development. Number 4 was grown in the poultry manure plot, number 3 was taken from the plot treated with 2 pounds 2 ounces of horse manure per square foot, and number 2 from plot 3 treated with a complete mineral fertilizer. Number 1 grown in a plot that was not fertilized has a long sparse root system with a few side roots. Such a root system is not desirable as the long tap root

Table 1.—Data on Fertilizer Plot in Norway Spruce 2 Year Seedlings

(Listed in order of development at the end of second year)

Plot.	Fertilizer used per plot of 3 Sq. Ft.	Top.		ROOT.		Total.		Remarks.
		Weight, (gr.)	Length. (ins.)	Weight. (gr.)	Length. (ins.)	Weight. (gr.)	Length. (ins.)	
1	Fresh poultry manure 2 lb.	.640	4.05	.500	10.39	1.140	14.44	Dark green.
2	Well rotted horse manure, 6 lbs. 1 oz.	.515	3.23	.295	8.88	.810	12.11	Long-Bushy.
3	$NaNO_3$ 4.402 gr.—KCL 8.803 gr.—Acid Phosphate 6.163 gr. (C-3)	.385	3.10	.370	7.40	.755	11.50	D. gr. Bushy.
4	$NaNO_3$ 12.496 gr.—KCL 5. 449 gr.—Acid Phosphate 18.606 gr. (Pa-1)	.365	3.54	.355	8.42	.720	11.96	Lg. fairly bushy.
5	Acid phosphate 9.303 gr.	.370	3.51	.295	9.86	.665	13.37	Lg. not bushy.
6	KCL 14.18 gr (Min-3)	.440	3.28	.300	8.20	.770	11.48	Lg. not bushy.
7	KCL 2.50 gr.—Acid phosphate 9.30 gr. (Pa-2)	.390	3.23	.255	8.23	.645	11.46	Average.
8	$NaNO_3$ 18.684 gr (Min-6)	.390	2.97	.230	8.05	.620	11.02	Root short bu.
9	$NaNO_3$ 3.124 gr. (surface treatment)	.340	3.13	.320	7.98	.660	11.11	Average.
10	Lime 93.03 gr.—Horse manure 4 lbs. 3 oz.	.330	3.45	.250	9.12	.580	12.57	Lg. not bushy.
11	$NaNO_3$ 4.402 gr.—KCl 8.803 gr.—Acid phosphate 6.163 gr. (surf. tr.)	.325	3.01	.290	8.30	.615	11.31	Top short.
12	KCL 2.722 gr.	.360	3.20	.330	8.50	.690	11.70	Average.
13	Lime 93.03 gr.—$NaNO_3$ 3.124 gr.	.370	2.88	.300	6.72	.670	9.60	Short but bushy.
14	$NaNO_3$ 6.241 gr.—Acid phosphate 9.303 gr. (surface treatment)	.340	2.96	.300	7.08	.640	10.04	Average.
15	Bone meal 18.606 gr.	.370	2.95	.265	7.94	.635	10.89	Bushy root.
16	Well rotted horse manure 2 lb.	.340	2.69	.285	8.56	.625	11.25	Average.
17	Bone meal 18.606 gr. lime 93.03 gr.	.405	3.28	.210	6.91	.615	10.19	Roots deficient.
18	Bone meal 18.606 gr.	.350	3.00	.260	7.97	.610	10.97	Roots long
19	Check.	.340	2.81	.270	7.81	.610	10.62	No side roots.
20	$NaNO_3$ 3.124 gr (C-2)	.390	3.19	.205	7.83	.595	11.02	No side roots.
21	Lime 186.06 gr (Min-2)	.260	2.50	.250	7.99	.590	10.49	Long roots.
22	$NaNO_3$ 6.241 gr.—Acid phosphate 9.303 gr. (C-4)	.325	2.92	.240	7.26	.565	10.18	Average.
23	$NaNO_3$—6.248. (C-8)	.330	3.06	.230	5.88	.560	8.94	Roots deficient
24	Acid phosphate 18.606 gr.	.280	2.41	.270	7.42	.550	9.83	Average.
25	Lime 93.03 gr.—(surface treatment)	.370	3.45	.180	6.20	.550	9.65	Light green.
26	Lime 93.03 gr.—Acid phosphate 9.303 gr	.335	2.33	.210	6.63	.545	8.96	Top short.
27	$NaNO_3$ 2.301 gr. KCl 4. 401 gr.—Acid phosphate 3.081 gr. (C-7)	.335	2.69	.202	7.51	.537	10.20	Average.
28	10 cc. concentrated NH_4OH to 2 qts. H_2O.	.335	3.15	.200	6.63	.535	9.78	Average.
29	KCl 3.749 gr.—(surface treatment)	.290	2.97	.240	8.60	.530	11.57	No side roots.
30	Well rotted horse manure 4 lb. 3 oz.	.330	2.88	.195	8.17	.525	11.05	Not uniform.
31	Acid phosphate 9.303 gr (C-5)	.330	3.06	.195	7.22	.525	10.28	Side roots.
32	Check.	.290	2.70	.230	7.47	.520	10.17	Few side roots.
33	Check.	.280	3.30	.235	7.50	.515	10.80	Not uniform.
34	Check.	.310	2.69	.190	8.02	.500	10.71	Long tap roots.
35	Lime 93.03 gr.—$NaNO_3$ 4.402 gr.—KCl 8.803 gr.—Acid phosphate 6.163 gr	.290	3.16	.205	6.10	.495	9.26	Short, bushy.
36	Check.	.295	3.01	.190	9.18	.485	12.19	No side roots.
37	$NaNO_3$ 6.241 gr.—Acid phosphate 9.303 gr. (same as No. 22)	.330	2.94	.155	8.13	.485	11.07	Yel. gr. and few s. rt.
38	Lime 93.03 gr. (C-9)	.325	2.68	.160	7.18	.485	9.86	Yellow green.
39	$NaNO_3$ 12.496 gr.—KCl 5.444 gr. (Pa-4)	.290	2.83	.195	7.02	.485	9.85	Fair.

Table 1.—*Concluded*

Plot.	Fertiliser used per plot of 3 Sq. Ft.	Top.		ROOT.		Total.		Remarks.
		Weight, (gr.)	Length. (ins.)	Weight. (gr.)	Length. (ins.)	Weight. (gr.)	Length. (ins.)	
40	Acid phosphate 9.303 gr. (same as No. 31) (C-5)	.290	2.47	.190	8.13	.480	10.78	Fair.
41	5 cc. concentrated NH_4OH to 2 qts. H_2O	.305	2.74	.170	6.66	.475	9.40	Poor.
42	$NaNO_3$ 6.241 gr.—KCL 7.498 gr. (C-12)	.280	2.42	.190	8.08	.470	10.50	Poor.
43	$NaNO_3$ 6.241 gr.—Acid phosphate 4.652 gr. (C-6)	.290	2.46	.180	7.27	.470	9.73	Poor.
44	$NaNO_3$ 12.496 gr.—Acid phosphate 18.606 gr. (Pa-6)	.230	2.47	.220	8.00	.440	10.47	Poor.
45	$NaNO_3$ 2.201 gr.—KCl 4.401 gr.—Acid phosphate 3.081 gr	.285	2.97	.170	6.69	.455	9.66	Poor.
46	Check	.260	2.82	.180	7.29	.440	10.11	Long tap root.
47	Bone meal 37.212 gr	.230	2.84	.210	7.16	.440	10.00	Poor.
48	$NaNO_3$ 6.248 gr.—Acid phosphate 18.606 gr. (C-13)	.240	2.37	.200	7.62	.440	9.99	Poor.
49	$NaNO_3$ 3.124 gr.—(same as No. 20) (C-2)	.240	2.25	.180	6.84	.420	9.09	Poor.
50	KCl 3.749 gr	.210	2.16	.190	7.09	.400	9.25	Poor.
51	Bone meal 18.606 gr	.190	2.92	.180	8.18	.370	11.10	No side roots.
52	$NaNO_3$ 6.248 gr.—KCl 3.749 gr	.260	2.17	.160	7.36	.370	9.53	No. side roots.

is usually broken off in lifting. The bushy abundant root systems possessed by plants 2, 3, and 4 gives assurance of ability to withstand drought and to grow rapidly when planted in the field.

Further confirmatory experiments will have to be conducted before definite conclusions can be drawn. It is interesting to note, however, that fresh poultry manure was most effective, its closest rival being horse manure and complete mineral fertilizers. With the exception of one plot all the checks were concentrated in the plots showing the poorer development. This would indicate that the soil in this nursery should be enrichened frequently with a well balanced mineral fertilizer or manure. Table one clearly indicates that similar treatment to every soil will not produce the same result as the results here obtained do not coincide with those of the other investigators. For this reason nurseries contemplating the use of commercial fertilizers should experiment on their own soils with the combinations that have elsewhere given the more beneficial results.

NEW CIRCULAR BULLETINS OF THE STATION

Circular Bulletin No. 84—Rose Culture.
Circular Bulletin No. 85—Honey Vinegar.
Circular Bulletin No. 86—Cherry Fruit Fly.
Circular Bulletin No. 87—Apple Maggot.
Circular Bulletin No. 88—Fertilizer suggestions for Calhoun County.
Circular Bulletin No. 89—Culture Greenhouse Lettuce.
Circular Bulletin No. 90—Cucumber Culture.
Circular Bulletin No. 91—Arbor Day Programs for Rural Schools.
Circular Bulletin No. 92—Garden Fowers.
Circular Bulletin No. 93—"Sting" on Apples.

Copies may be secured free upon request to R. S. Shaw, Director, East Lansing, Michigan.

EMERGENCY HAY AND PASTURE CROPS

Special Bulletin No. 150 is the official designation of a new publication by the Agricultural Experiment Station of the Michigan State College, entitled "Emergency Hay and Pasture Crops," by C. R. Megee. This bulletin is of particular interest this year. Cultural methods and the merits of the following crops are considered in this publication; soy beans, sudan grass, millet, oats and peas, rye and vetch, rape, corn, sorghum and sweet clover. Information is given also relative to the yields and the relative feeding value of the various emergency hay crops in the southern and northern sections of Michigan. A copy of this bulletin may be secured free upon request of R. S. Shaw, Director, East Lansing, Michigan.

PROFIT IN AGRICULTURE

Proper Marketing is an Essential factor but it Must be Accompanied by Successful Production

J. T. HORNER, ECONOMICS SECTION

Farmers are striving so to conduct their business that they may have more of those things necessary for the satisfaction of wants. No civilization is able to advance in learning and culture unless its people are freed from the never-ceasing struggle for bread. It is only when man is able to secure something more from his efforts than those things needed for the barest subsistence that a real culture can be developed.

As man marches up the scale of civilization and by his ingenuity and industry makes his efforts more productive he constantly adds to the number of things he desires. It seems that wants multiply more rapidly than our ability to produce. Things that were once luxuries for the chosen few are now necessities for the masses. During the past twenty years the standard of living of farmers has very greatly increased. The farmer of today is enjoying many things of which his parents were ignorant.

In former days the farmer enjoyed the things which he produced for himself. Very few things were purchased. There was little need of money. Today, however, the farmer goes into the markets of the world with the product of his land and labor and fetches back goods which come from the ends of the earth. This is a day of commercialized agriculture. It is a day when the farmer is primarily concerned with his money income.

Before the day of commercialized agriculture, when the greatest problems were those of making Nature provide a sufficient harvest, attention was given to the scientific principles of production. Every effort was expended upon the problem of making the land and livestock of the farmer yield the greatest returns. As we passed more into the money economy period and the farmer sold more and more of his produce and used less and less for his own wants the problem of the market became of greater importance. In the early part of the present century the market began to attract attention. It was thought that the great difficulty with agriculture was that of the market. Many theories were advanced as to what should be done. So great was the belief that the market was the fundamental ailment of the farmer that the science of agriculture was discredited.

No one would assert that the market is not of importance; but let us analyze the factors which really have an influence on the income of the farmer.

In certain sections of the country, farm improvements are better than in others. In some neighborhoods the buildings are poor and unpainted. Fences are in a bad condition. Farm machinery seen in the fields or farm yard is in a poor state of repair. Roads are poor. The home surroundings are unclean and uninviting and the whole farmstead does not reflect a good

standard of living. The women are forlorn looking and the spark of hope does not shine from the eye of man.

Why is this? Why is there wealth in some sections upon which a happy, educated and cultured farm population thrives while in others there is poverty, lack of education and culture, and a hopeless population?

However, in these poor sections we sometimes find a very prosperous looking farm. The farmer has accumulated some wealth farming the same kind of land under the same climatic conditions and selling in the same markets as his poverty stricken neighbors. In prosperous sections we sometimes find farmers who cannot make the farm go and are always hard up while their neighbors are well-to-do. Why these differences?

In analyzing the conditions of agriculture we must take into consideration all the factors which have to do with prosperity. The market is one of these factors but it is not the only one.

The prosperity of agriculture depends upon:

1. Net income.
2. What is done with the income.

Net income depends upon:

1. The price.
2. The quantity of product for sale.
3. The expense or outlay in production.

Leaving the matter of price for later consideration let us look at the other factors affecting net income, that is, the quantity of produce for sale, and the expenses of production.

These things depend upon:

1. The climate.
2. The soil.
3. The equipment.
4. The man.

The man:

1. How well does he manage his land and his equipment?
2. How well does he utilize his time and that of his laborers?
3. How well does he select those crops which are suited to his soil and climate?
4. How well does he select those crops which sell best in the market?
5. How well does he select his equipment?

The quantity of produce which the farmer will have to sell at the end of the season depends upon:

1. The climate. Climate is something over which man has no control, and in agriculture climate is a greater factor influencing production than in any other business. The farmer can combat an unfavorable climate only by choosing those crops which are best suited to the climate and by planning his work so that unfavorable climate has the least detrimental effect. Though it is impossible to set aside climatic conditions the wise farmer plans his enterprises to fit in best with them.

2. The soil. The quality of the soil has a great influence on the size of the crop and the quality of the product. Industry and science can do much to bring profit from poor land but the man with the best land has advantage which is of importance in the competitive struggle. Poor land can

be made better by proper methods of cultivation, rotation, and fertilization. However, land must be productive or profit will never come. Many men are wasting capital and labor on land which will never yield a comparable return. It is a mistake to hope that some sort of a marketing system can be devised to make profit return from unfertile soil.

Good land and a favorable climate are the basis upon which a prosperous agriculture may be built; but these things do not necessarily insure profit. On the other hand, though poor soil and unfavorable climate are handicaps to agriculture, it does not necessarily follow that under these conditions failure will always result.

3. Equipment. For economy and proper cultural methods certain equipment is necessary. Other things being equal, the better the equipment the more certain profit is to come. This does not mean that expensive equipment is necessary. In many instances cheap equipment is more adequate to the requirements of the farm than that which costs much. The right kind and right quantity of equipment rather than much expensive equipment is what is needed. Machinery is for the purpose of saving labor and doing work in a better manner. When the right kind is secured and used in the right way this will be the result.

4. The man. The man is the most important factor influencing the profit from agriculture. If the farm has the right kind of management the results are going to be different than if shiftlessness holds sway. The quantity of the produce which there is for sale at the end of the season and the expenses of producing this produce are factors which greatly influence net income. These things are dependent to a great extent upon the man.

How well does the man manage his land and his equipment? Does the farmer know how to cultivate his fields so as to conserve moisture and maintain fertility? The right combination of horse or tractor power, machinery, land and labor are factors which influence costs. Is proper equipment selected. The man who knows how to manage his land and his equipment so that capital invested is not more than can be efficiently utilized is going to be far ahead in his struggle for profit.

How well does the farmer utilize his time and that of his laborers? Men in most lines of business, the professional man and the laborer are compelled to work rather steadily and diligently throughout the year. The prosperous farmer learns to plan his work so that he is employed throughout the year and attempts to manage his farm so that there is a rather even distribution of labor. Not only must the work be managed so that there is employment throughout the year, but men must be managed so that the fullest accomplishment results from the work. There are some men who can get lots of work done with few men and little effort. On the other hand, there are men who seem to be always working and have many men helping them; but never accomplish much and are always behind with their work.

Proper selection of and use of equipment, proper management of land, and proper utilization of labor are essenials to the production of quality and quantity products at low costs. Such production is essential to a prosperous agriculture, for no market system will ever be devised which will bring profits to an inefficient agriculture.

With quality produce produced at low costs the farmer is ready to go to market and be in a favorable competitive position. The price is the other factor which determines the net income. We do not have enough information about markets and prices to tell definitely the influence of the different factors on price. The quantity of produce available is one of the most im-

portant factors. Another is the purchasing power of the consumer, and still another factor is the bargaining power of the two parties to the sale. If the seller is forced to sell, whether he thinks the market favorable or not, a just price is not likely to be the result. The man who has no adequate storage facilities or hasn't adequate finances must sell regardless of the price. In other instances the farmer does not have information about market conditions and does not know whether the price offered is right or not. Sometimes farmers refuse to sell their produce when the prices offered is all that market conditions justify and are later forced to sell at lower prices.

The individual farmer can do much toward securing a better price for his produce if he will produce those crops or livestock products which will sell best in the market. The farmer, as every other man who sells the product of his capital and labor, must know about the demand of the market and produce those things which will sell best. Regardless of everything the individual might do, there will be times when price levels will be unfavorable. However, strict attention to market requirements and proper selection of crops will do much to bring about favorable prices.

During the past few years, when so much attention has been given to the market, there has been a tendency to forget the other factors which influence the profit of the farmer. The market must not be neglected. We need to give this side of the business the most careful and sincere study and aim to eliminate all inequalities of trading and those practices which add to costs. However, while we are working on the market practice side we must continue to give attention to the other phases of our business. As in every other line of business, the most important factor is the man. No market system will ever be devised which will bring prosperity to the farm where economy, industry and scientific methods are strangers.

FUEL COSTS OF A PRIVATE LIGHTING PLANT

A Report of Records on a 110 Volt 4 Cylinder Automatic Electric Plant

F. E. FOGLE, AGRICULTURAL ENGINEERING SECTION

In the Quarterly Bulletin No. 4, Vol. 3, issued in May, 1921, appeared an article on the cost of producing electric current with a private plant. The tests for fuel consumption reported in this article were made on the plants of the single cylinder type, equipped with a 32-volt storage battery. The current was measured as it came from the generator and not after passing through the storage battery.

The cost of fuel per kw. hr. corrected to 20c per gallon for gasoline, ranged from $0.0534 for the most economical plant to $0.1354 with an average cost of $0.0817 per kw. hr. Since that time, 110-volt, 4 cylinder plants of the automatic type, using a battery of the automobile type for starting purposes only have come on the market. This type of plant is specially adapted to cases where current must be carried several hundred feet to the

Table 1.—Record of plants from May 1, 1924 to January 1, 1926.

	Gals. gasoline used.	Gals. oil used.	Kw. Hrs. produced.	Repairs excluding labor.
May, 1924	53	3	71	$11.40
June, 1924	70	2¼	83	....
July, 1924	46	4¼	72	1.80
August, 1924	92	5½	122	4.70
September, 1924	100	6½	172	....
October, 1924	111	9	228	8.59
*November, 1924	138	11½	328	....
December, 1924	140	6¼	354	4.59
January, 1925	251	4¼	435	1.80
February, 1925	142	3¾	267	....
March, 1925	136	3½	218	45
April, 1925	119	3¾	201	....
May, 1925	165	2½	181	....
June, 1925	132	4¾	144	....
July, 1925	140	4½	161	....
August, 1925	168	6½	268	....
September, 1925	184	5	370	....
October, 1925	183	4½	350	10.31
November, 1925	194	5½	404	....
December, 1925	204	6¼	472	....
Total	2768	103	4901	$43.64

*Second Unit Installed.

point of consumption and in cases where larger quantities of current are used, than the average farmer consumes.

A plant of this type, in a 1,500 watt size, was installed at the Upper Peninsula Experiment Station at Chatham, in November, 1923. On May 1, 1924, the plant was equipped with a Watthour meter. Records of current produced, gasoline and oil consumed and cost of repairs, excluding labor, have been kept since that time.

On November 1, 1924, a second plant of the same size, type and make was installed. This was installed in such a way that it automatically started when the current demand became too heavy for a single plant to carry. The performance and operating costs of these plants are shown in Table 1.

All calculations are made on the basis of gasoline at 20c per gallon.

Table 2.—The fuel consumption for various loads of a 110-volt, 4-cylinder plant of the automatic type.

Load in watts.	Voltage maintained.	Gals. of gasoline consumed per kw. hr	Cost of fuel per kw. hr. gas at 20c per gal.
45	103	4.16	$0.832
95	109	2.07	.414
180	114	1.185	.237
540	108	.487	.0074
1083	114	.287	.0574
1484	106	.245	.0490
1800	100	.223	.0446

*The generator did not maintain rated voltage because it was not properly adjusted. A factory representative later made adjustments so that the plant maintained its rated voltage.

During the first month 53 gallons of gasoline were consumed to generate 71 kw. hr. of current at a cost for fuel of $0.1492 per kw. hr. During the last month recorded 204 gallons were consumed to produce 472 kw. hr. of current at a cost of $0.0864 for current. Considering the total time the plants were operated, 0.564 gallons of gasoline were required per kw. hr. of current produced. The cost of fuel per kw. hr. was $0.1128.

Recently a series of tests were conducted by the writer to determine the fuel consumption for various loads, of a plant of the same make, size, type and voltage as the plants previously discussed. Table 2 shows the results of these tests:

THE WATER CONTENT OF CERTAIN SOIL TYPES IN MICHIGAN

J. O. VEATCH, SOILS SECTION

The water content or moisture in the soil bears a close relation to the chemical reactions which take place in soil, to natural productiveness, to the efficiency of fertilizers and therefore to various phenomena of plant growth and crop yields. The amount of water, fluctuations in amount, distribution throughout the soil profile and availability, comprise knowledge which must be obtained before logical explanations can be given of the chemical and physical nature of the soil profile, the distribution of plant roots, and the composition of plant associations. Such knowledge will enable us to predict with greater certainty the degree of suitability of any particular soil type for a particular plant. It is generally accepted that, in arid and semi-arid regions, the moisture in the soil is the chief controlling factor in plant growth; in humid regions also, moisture may be the chief limiting factor in plant growth on certain soil types.

The water of the soil is a variable, since it fluctuates throughout the year according to the precipitation and the evaporation or humidity; according to the plant cover, and according to the different layers or horizons of the soil. Therefore, a single determination has scarcely any significance; observations clearly must be conducted throughout the year and over a period of years.

The Soils Section of this Station is engaged in collecting data on moisture according to soil types, as distinguished in the classification made by the Soil Survey, and in relation to the natural divisions or horizons of the soil rather than to fixed or arbitrary depths for all soils alike. This procedure it is believed will give results having comparative value and wide application, with a minimum number of samples and determinations, since the distribution of the soil type is known.

Tables 1 and 2 give summaries of determinations made during 1924. They are considered suggestive and indicative but the results, of course, are not considered as complete or conclusive.

The results indicate that a considerable difference may exist in the moisture content of the well drained sandy soils of the State. Determinations made (but not shown in the averages in the tables) indicate that at certain times the content of water may be as low as 1.5 per cent in certain horizons of the Grayling sand type and that the maximum amount of water in this

Table 1.—Content of water in three types of soil in Michigan, 1924.

Soil type	Soil horizon and depth	Average moisture, percent dry basis		Precipitation and temperature departure from normal, inches and degrees F.						Date samples collected
		Bare plot	Alfalfa	April	May	June	July	Aug.	Sept.	
Grayling Sand Grayling	A_o A_1 0 to 6 in.	6 65	4.52	Precip.	Precip.	Precip.	Precip.	Precip.	Precip.	April 29 to Sept. 30
	B 6 to 18 in.	5.41	4.27	−0 29	+3.09	+0.23	+3.21	−0.72	+0.28	
	C_1 18 to 32 in.	3.68	3.40	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	
	C_2 32 to 48 in.	3.56	2.07	−2.9	− 7.5	− 2.4	−3.5	− 1.5	−4.0	
Mancelona Sandy loam Mancelona	A_o A_1 0 to 7 in.	9.25	10 21	Precip.	Precip.	Precip.	Precip.	Precip.	Precip.	April 30 to Oct. 3.
	B_1 7 to 12 in.	7.37	7.62	+0.26	+2.37	+1.54	+1.41	+1.55	0.00	
	B_2 12 to 30 in.	7.70	6.38	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	
	C 30 to 48 in.	4 52	3.37	....	−5.0	−1.4	−4.0	−0.5	−5.1	
Coloma Sand East Lansing	A_o A_1 0 to 7 in.	8 59	7.33	Precip.	Precip.	Precip.	Precip.	Precip.	Precip.	April 10 to Sept. 2
	B 7 to 24 in.	6.42	4 98	−0.08	+0.62	+1.54	−0 54	−0.62	−0.04	
	C_1 24 to 40 in.	5.00	4 32	Temp.	Temp.	Temp.	Temp.	Temp.	Temp.	
	C_2 40 to 60 in.	5.20	4.79	−1.0	−6.5	−3.0	−3.5	−1.7	−4.6	

Table 2.—Comparison of moisture in two soil types under forest, 1924.

Grayling sand, Grayling, Jack pine forest			Hillsdale sandy loam, East Lansing, Virgin hardwood forest		
Date, samples collected	Soil horizon and depth	Moisture, percent (Average)	Date, samples collected	Soil horizon and depth	Moisture, percent (Average)
April 29. June 5, 22.	A_o A_1 0 to 3 in.	7.43	May 31, July 5.	A_o A_1 0 to 4 in.	33.90
July 20.	B 5 to 15 in.	5.01	July 28, Sept 2.	A_2 4 to 20 in.	14.21
August 5.	C_1 15 to 32 in.	3.49		B 20 to 40 in.	13.98
Sept. 9, 30.	C 32 to 48 in.	3.80		C 40 to 60 in.	15.18

type of soil is relatively low, probably not exceeding 10 per cent. There is further a suggestion that for all of the soil types sampled, the water content is fairly constant in the C horizons or at depths of 3 to 5 feet and that very little of the summer precipitation penetrates to these depths. The greatest fluctuation in the amount of water appears to be in the surface horizon.

The comparison of soils under forest at Grayling and East Lansing reveals a marked difference in types. The soil with the higher moisture supports a hardwood forest and an enormously greater volume of plant growth.

BUCKWHEAT IN MICHIGAN

Special Bulletin No. 151 by C. E. Cormany contains valuable information for the buckwheat grower in Michigan. The principal paragraphs deal with varieties to plant, soils, rotations, rate and time of sowing, preparation of seed bed, fertilizers and harvesting. Among the uses of buckwheat are listed its value: as a weed destroyer, as a cover crop in orchards, as bee pasture, as an emergency crop and as a companion crop. The summary states "buckwheat is a good crop on poor thin lands and on slightly acid soils. It does well on new land and on old sod land." A copy of this or of other bulletins of the station may be secured free upon request to R. S. Shaw, Director, East Lansing, Michigan.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, Agricultural Experiment Station, East Lansing, Michigan.

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MICHIGAN STATE COLLEGE
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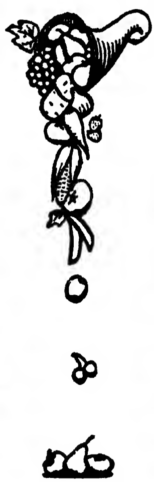

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GROUND ALFALFA FOR DAIRY COWS

Grinding Alfalfa Hay For Dairy Cows Is Not Profitable, According to the Results of This Trial

O. E. REED AND J. E. BURNETT, DAIRY SECTION

Many inquiries have been received at this Station relative to the value of grinding or chopping hay and other roughage for dairy cows. To answer these questions a trial was conducted during the summer and fall of 1925 in which ground alfalfa hay was fed in comparison with unground hay to dairy cows.

Two lots of six cows each were selected from the College dairy herd for this experiment. Care was taken in the selection of the cows so that they would be balanced against one another as nearly as possible as to stage of lactation, date of breeding, weight and age. Lot A was composed of Holstein cows numbers 39, 129, 150, 153, 130 and the Ayrshire cow number 161. Lot B was composed of Holstein cows number 47, 143, 152, 155, 171, and the Ayrshire cow number 164. The double reversal method was used in this trial.

The trial was divided in three periods of thirty days each, the first ten days of each period being regarded as a preliminary feeding period. The data collected for these ten-day periods were not used in computing results. Thus Lot A was fed unground alfalfa for the first thirty-day period, then changed to ground hay for the second thirty-day period, and returned to the unground hay for the third thirty-day period. Lot B received ground alfalfa for the first thirty-day period, then changed to unground hay for a period of thirty days and returned to the ground hay for the third period.

All cows were fed alfalfa hay at the rate of one pound of hay for each hundred pounds of live weight, one-half pound being the smallest fraction of a pound recognized. Silage was fed throughout the trial at the rate of three pounds for each hundred pounds of live weight. The hay and silage were fed twice per day. Grain was fed at the rate of one pound of grain for each three and one-half pounds of milk produced by the Holstein cows and one pound of grain for each three pounds of milk produced by the Ayrshires. Changes in the amounts of hay, silage, and grain were made at the end of each ten-day period.

Throughout the test each animal was weighed daily and at the same hour each day. All cows were milked four times daily throughout the trial and samples of milk were taken from each cow at each milking for the purpose of determining (by the Babcock method) the percentage of fat that it contained.

The normal decline in milk and fat production for a group of cows is very difficult to measure when the conditions under which they are maintained are changed, but it would be expected that an average of the first and third twenty-day periods would give the normal productions during the second or middle twenty-day period. In this way the production of milk and butter fat during the first and third periods were averaged and compared to the amount produced during the second period, the difference from actual production being considered as due to the influence of the ground or unground hay as the case might be.

The alfalfa used was rather poor quality first cutting hay. This poor quality hay was selected because it was believed that there would be more difference in feeding value between the ground and unground hay than if good hay were used. The silage was of good quality, made from corn well into the dent stage. The grain mixture fed consisted of 400 pounds of ground corn, 400 pounds of ground oats, 125 pounds of linseed meal (34 per cent), and 100 pounds of cottonseed meal (43 per cent). This mixture contained 14.1 per cent digestible crude protein and 78.0 per cent total digestible nutrients, according to tables in "Feeds and Feeding" by Henry and Morrison.

The above ration supplied the nutrients needed by the cows as indicated by the fact that the weights of the two groups of cows varied only slightly throughout the entire 90-day period. The variation in weight was not great enough to be considered in the final results. The results of the trial are stated in Table 1.

Table 1.—The tabulated results of a trial covering a 90-day period feeding ground and unground alfalfa hay to two lots of six cows each.

Lot A	Pounds milk	Pounds fat
1st 20 day period, unground hay	5,920.5	176.234
2nd 20 day period, ground hay	5,335.4	160.151
3rd 20 day period, unground hay	4,787.5	143.134
Average 1st and 3rd periods	5,354.0	159.684
2nd period, ground hay	5,335.4	160.151
Difference in favor of unground hay	18.6	.533
Lot B		
1st 20 day period, ground hay	5,368.3	154.944
2nd 20 day period, unground hay	4,741.8	136.701
3rd 20 day period, ground hay	4,240.7	124.075
Average 1st and 3rd periods	4,804.5	139.509
nd period, unground hay	4,741.8	136.701
Difference in favor of ground hay	62.7	2.808
Final results for the two lots		
Difference in favor of ground hay in Lot B	62.7	2.808
Difference in favor of unground hay in Lot A	18.6	.533
Difference in favor of ground hay for six cows for 20 day period	44.1	2.275

Lot A produced 18.6 pounds more milk and 0.533 pounds more butter fat during the twenty-day period when they received unground hay than they produced during the period when they received ground hay. Lot B pro-

duced 62.7 pounds more milk and 2.81 pounds more butter fat on the ground hay than they did when unground hay was fed. When both lots are considered together the production of six cows was 44.1 pounds of milk and 2.28 pounds butter fat greater for the twenty-day period when they received ground hay.

The average increase of production for the twenty-day period when the six cows received the ground alfalfa was less than 0.4 pounds of milk and 0.014 pounds of butter fat per cow per day.

The results obtained in this trial show no greater variations between the feeding of unground and ground hay than would be expected if the same ration was fed throughout the entire experiment.

Therefore, the conclusion to be drawn from this trial is that the grinding of alfalfa for dairy cows is neither necessary nor profitable.

FINISHING BABY BEEF

The Results of the Third Year's Work at This Station in Fattening Baby Beef Calves

G. A. BROWN AND G. A. BRANAMAN, ANIMAL HUSBANDRY SECTION

The third year's work in fattening baby beef calves for market has been completed at this Station. The results of this experiment may be compared with those obtained in the two previous trials, which were reported in the Quarterly Bulletins for August, 1924, and August, 1925.

The steer calves purchased on the Chicago market, October 29, 1925, would have graded good to choice and were of mixed beef breeding, with white-faces predominating. After arrival at the College feed lots, a few bulls in the bunch were castrated and all of them were tested for tuberculosis and dehorned.

Alfalfa hay and corn silage were fed until November 13, when the experimental feeding began. Individual weights were taken November 12, 13 and 14 and the average considered the initial experimental weight. Weights were taken every ten days throughout the feeding period.

The cost in the lots on November 13 was $8.50 per hundred pounds, including Chicago cost, freight, feed for two weeks, and veterinary expense.

Objects of Experiments

(1) Comparison of self-feeding of grain versus hand feeding a lighter ration, plus linseed meal added in each case with corn silage and alfalfa hay supplied according to appetite.

(2) Linseed meal in comparison with alfalfa hay as the source of protein in the hand-fed ration.

Rations Fed

The basal ration of silage and alfalfa was fed in all lots throughout the experiment. Each lot received all the silage they would clean up readily twice per day, and alfalfa hay was kept before them in racks.

A mixture of equal parts, by weight, of shelled corn and whole oats was fed all lots the first 60 days, three parts corn and one part oats the next 30 days, and corn alone the last 105 days. The calves in Lot 1 and Lot 2 each received one pound of oilmeal per day the first 60 days, one and one-half pounds per day the next 75 days and two pounds per day the last 60 days, fed on the silage night and morning.

Lot 1 was put on a self-feeder of grain at the end of 30 days, when by gradual increase they had reached a full feed. Lot 2 was hand fed, twice daily, approximately two-thirds the amount of grain consumed by Lot 1, beginning with about a half-feed for the first 60 days and gradually increasing to a nearly full feed for the last 60 days. Lot 3 received no oilmeal but was fed an amount of grain equal to the sum of the grain and oilmeal fed

Table 1.—A summary of the results of the third year's work at this station in fattening baby beef calves for market.

9 steers per lot—195 days	November 13, 1925—May 27, 1926.		
	Lot 1	Lot 2	Lot 3
Initial cost in lots	$8.50	$8.50	$8.50
Initial weight per calf	407.2 lbs.	411.3 lbs.	407.2 lbs.
Final weight per calf	883.3 lbs.	864.3 lbs.	781.1 lbs.
Total gain per calf	476.1 lbs.	453.0 lbs.	373.9 lbs.
Average daily gain	2.44 lbs.	2.32 lbs.	1.92 lbs.
Total feed consumed per calf:			
Shelled corn	1758 lbs.	1203 lbs.	1374.4 lbs.
Oats	340.7 lbs.	199 lbs.	233.7 lbs.
Linseed oilmeal	270.9 lbs.	277.7 lbs.	....
Alfalfa hay	367.2 lbs.	707 lbs.	724.8 lbs.
Silage	1035 lbs.	3599.4 lbs.	2237 lbs.
Average daily ration:			
Shelled corn	9.02 lbs.	6.17 lbs.	7.05 lbs.
Oats (fed 90 days)	1.75 lbs.	1.02 lbs.	1.20 lbs.
Linseed oilmeal	1.39 lbs.	1.42 lbs.	....
Silage	9.92 lbs.	18.46 lbs.	11.47 lbs.
Alfalfa hay	1.88 lbs.	3.63 lbs.	3.72 lbs.
Feed per cwt. gain:			
Shelled corn	369.25 lbs.	265.56 lbs.	367.59 lbs.
Oats	71.56 lbs.	43.93 lbs.	62.50 lbs.
Linseed oilmeal	56.90 lbs.	61.30 lbs.	....
Silage	406.43 lbs.	794.56 lbs.	598.30 lbs.
Alfalfa hay	77.13 lbs.	156.07 lbs.	193.85 lbs.
*Feed cost per cwt. gain	$9.28	$9.39	$9.22
Feed cost per cwt. gain (deducting pork)	8.68	8.71	8.54
Necessary selling price (deducting pork)	8.60	8.61	8.52
**Selling price in lots	9.40	9.40	8.65
Initial cost of calf	34.61	34.96	34.61
Cost of feed	44.19	42.56	34.46
Total cost	78.80	77.52	69.07
Value of pork from droppings	2.86	3.08	2.52
Total cost crediting pork	75.94	74.44	66.55
Final value in lots	83.03	81.25	67.56
Profit per calf (not considering pork)	4.23	3.73	1.51
Profit per calf (pork included)	7.09	6.81	1.01
Price returned per bu. corn fed (including pork)	98	1.07	79

*Prices of feeds and pork: Corn 75c per bu., oats 44c per bu., oilmeal $55.00 per ton, silage $5.00 per ton, alfalfa $20.00 per ton, tankage $60.00 per ton, pork $13.00 per cwt.

**Selling price in lots is Detroit value less 85c per cwt.

in Lot 2. However, 50 days before the close of the experiment they refused to take the increased ration except for the last few days of the experiment. Their consumption of silage was considerably less throughout the feeding period.

Water, in tubs, was kept before the calves at all times, and a mixture of salt, bone flour, and sulphur was supplied. The calves were housed in a shed with doors opening to the east into small, cinder paved lots. These doors were open except on the very coldest nights.

Gain by Pigs is Small

Two pigs were included with each lot of calves. These pigs were fed shelled corn and tankage at night, as much as they cleaned up readily. One pig in each lot would hardly have handled the feed available, judging from the amount of extra feed supplied.

Corn Replaced by Silage and Alfalfa

A comparison of the first two lots indicates that part of the grain of the self-fed lot may be replaced with silage and alfalfa especially during the early part of the feeding period. The second lot gained almost as rapidly and showed a similar market finish, selling at the same price. The cost of gains was practically the same and the return above feed cost was only 28 cents per calf more in the self-fed lot. However, profits are materially influenced by variation in feed prices. Corn prices have been relatively low and alfalfa relatively high the past season. When corn is higher in price or alfalfa cheaper, the self-fed grain lot loses its slight advantage and the second lot shows a greater profit. The second lot shows a greater return per bushel of shelled corn fed when the profit is all credited to the corn and other feeds charged at market value.

Linseed Oilmeal Profitable

The most noticeable feature in the results of the experiment is the poorer showing of lot 3. These calves were fed exactly the same as those in lot 2 except for the omission of the linseed oilmeal in the ration. An equivalent weight of grain was fed instead. The calves consumed less feed, gained less rapidly, showed less finish, produced less pork and sold cheaper on the market.

It was noticeable throughout the feeding period that the calves receiving oilmeal had better appetites, were always ready for their feed and cleaned it up readily. The other lot, however, was easily overfed; they did not show keen appetites at feeding time and, in fact, went off feed for several days near the close of the experiment. Calves fed in this way in the two previous trials have shown similar tendencies, although not quite as markedly as in this trial. A slightly cheaper cost of gain is shown but not enough is saved to counterbalance the lower selling value. In order for each lot to break even, lot 3 could have sold for nine cents per cwt. less than lot 2; however, the difference in selling value on the market was 75 cents.

The calves were valued in the lots at the close of the experiment by a packer buyer and a commission representative from the Detroit market, as follows: Lot 1, $10.25; lot 2, $10.25; lot 3, $9.50. Experience in shipping indicates that on the average about 85 cents per cwt. will cover the marketing expense, freight and shrinkage from Lansing to Detroit.

Good Market Price for Feed

The profits per calf above feed cost in this experiment do not seem high though the feed has been sold at a good market price with no more labor than would be necessary to haul the feed to market. Furthermore a generous supply of manure has been produced which means fertility returned to the soil. If the profit returned is credited to the shelled corn fed after other feeds are charged at market price, a price per bushel of 98c, $1.07 and 79c respectfully has been paid by the various lots of calves.

FIBER FLAX VARIETY TEST 1925*

B. B. ROBINSON, FARM CROPS SECTION AND U. S. D. A. BUREAU OF PLANT INDUSTRY CO-OPERATING

The United States, through the Department of Agriculture, has the distinction of being one of the first countries to make an effort to improve fiber flax by scientific plant improvement methods. From the results of early selections made in Michigan in 1909 and others in later years, together with selections from numerous crosses there have arisen a number of very outstanding strains of fiber flax. A number of these selections are included in the test reported in this paper, but by far the greater number will have to be increased for a few years before it will be possible to produce seed enough to test them in large plats or to distribute them.

Saginaw flax was the first variety resulting from the breeding work with fiber flax, and its seed has been distributed since 1918. Because of the high standing of Saginaw flax at East Lansing, Michigan, and its adaptation to the conditions there, it was used as the standard or check variety in the test. It has been used also in many tests throughout the world and the results have been favorable, wherever reports have been returned.

This variety test included not only the more promising strains of flax from the breeding work, but also the popular commercial kinds of seed. Because of the limited amount of information on the yielding ability of many of these varieties under Michigan conditions it seems advisable to print this preliminary report.

Soil

The experiment was conducted on a medium sandy loam. The field was broken for the flax from an old clover and timothy sod. It is very probable that the soil was quite acid from the number of sheep sorrel, (*Rumex acetosella*), plants that were plowed under. The soil in an average year would have had sufficient moisture to produce a flax crop, but during the excessive drougth of the 1925 growing season it could not retain sufficient moisture and the flax suffered badly on that account.

*Fiber flax breeding has been carried on since 1918 in co-operation with the U. S. D. A., Bureau of Plant Industry, Office of Fiber Investigations.

Plats

The plats were 236 feet long, 44 inches wide, and lay parallel to one another. Only ten-inch spaces were allowed for alleys between adjacent plats. These spaces were hoed clean of weeds twice during the growing season. Every third plat was planted with the Saginaw variety as a check. All other varieties were duplicated in the series and a few varieties were represented by four plats each.

Fig. 1.—Fiber flax plats shortly after germination of the flax. Plats were eleven rows or 44 inches wide, and 236 feet long. Every third plat was planted with Saginaw flax which was used as the check variety. All varieties were duplicated in the series and in some cases planted four times.

Seeding and Harvesting

The seed was drilled in, using eleven holes of a grain drill whose feed tubes were four inches apart. This method gave eleven rows four inches apart for each plat. The rate of seeding was 70 pounds to the acre for all varieties. The seeding was done on April 7 and 8. This is early for flax seeding at East Lansing, Michigan. Usually, early plantings of flax thrive better than late plantings, but the season of 1925 was an exception and the later plantings grew better as they received more benefit from the late rains.

At harvest the flax on all plats was pulled by hand and allowed to dry for several days before weighing and threshing. The varieties were harvested as they matured and for this reason the harvest extended over a period of six or seven days. Ottawa 770B flax and the Ireland Pure Line flax matured first and these plats were harvested first. The Saginaw flax in the check plats was all pulled on the fifth day of harvesting.

Growing Season Abnormally Dry

The 1925 growing season for flax was exceptionally poor due to continued dry weather. There were 10.93 inches of rainfall for the seven months

preceding planting in April, when the normal rainfall for this period is 15.71. This deficiency of 4.78 inches of rainfall before planting caused the seed bed to be very dry. Then from the time the flax was planted until the end of the harvest on July 23, 1925, there were only 5.26 inches of rain. This was a deficiency of 6.65 inches for the growing period compared to the normal of 11.91 inches.

The continuous dryness caused a very short growth of stem. The growth of the varieties was measured in the field and varied from 10 inches from the ground to the top of the panicle (Ottawa 770B) to 21 inches for a number of the higher yielding varieties. This shortness of stem made most of the varieties unsuited for line fiber, but as these were experimental plats they were worked up for tow yields. It is often the exceptional year that makes a variety stand out above the others and the condition of the 1925 season may have had its effect on the standing of the varieties for 1925.

The Fiber and Seed

As mentioned previously, due to the short growth of stems, the varieties were unsuited for line fiber; so no effort was made to make any line, and tow only was produced. The fiber yields in the tables therefore represent a weight of fiber that is all tow. For all the varieties the tow was of very poor quality, and low in tensile strength. This condition of the fiber was somewhat general in Michigan in 1925 and therefore it was thought the weather influenced it somewhat, but over-retting was partly the cause at East Lansing. In arranging the varieties in Table I and Table II only the yield of tow and seed was taken into account, and the quality of the tow was not considered. This naturally gives varieties that yield a poor quality of tow an advantage in comparison with varieties that produce a high grade.

The fiber yields are calculated from uniform samples of each variety that were water retted, and dried indoors. These samples were about 1/11 of the total weight of the straw.

The seed was all of a very good quality. It was exceptionally free from weed seeds or trash and had a bright glossy appearance. The yields were low because of the dry weather but this had its effect on all varieties.

Discussion

From one year's results it is impossible, in work of this kind, to make conclusions that would hold good in all years. However, the results obtained may be significant. It will be noticed that all the commercial varieties are high in seed production and low in fiber yields. Undoubtedly for fiber production this condition is wrong, as the fiber in the straw is the main source of income, with the seed a very important by-product. Hence, the breeding work has attempted to increase the fiber yields without greatly reducing the seed yields.

In Table I, it is apparent that the second trial for Ireland Pure Line No. 5 flax gave a low per cent seed yield, namely 71.52 per cent of the yield of Saginaw flax. This is 56.61 per cent lower than the first trial; therefore, it seems apparent that some experimental error existed here and in all probability the yields should both be close to 128 per cent. This would give the variety a higher standing.

Table I and Table II indicate that for fiber purposes in Michigan, Ottawa

770B, Ireland Pure Line No. 5, Ireland Pure Line No. 3, and common Blue Blossom Dutch flax grown in this country several years will not give the best fiber yields. Saginaw and Ottawa Longstem are probably the best fiber yielding sources of home-grown flax. White Blossom Dutch flax seems to give good yields and might be recommended if imported seed is used. This variety gives a rather coarse fiber.

Table 1.—Comparison of varieties of flax by percentage of check.

Variety	Yield seed per cent of check					Yield fiber per cent of check					
	1st plot	2nd	3rd	4th	Ave.	1st	2nd	3rd	4th	Ave.	Value
23012	82.10	85.74			83.92	108.02	123.97			116.00	107.98
23111 x 23211	102.99	96.72			99.86	117.03	101.39			109.21	106.87
1805–21	87.13	91.38			89.26	107.20	117.23			112.22	106.48
*Ottawa Longstem	120.81	138.25			129.53	89.43	103.34			96.39	104.68
1923 x 1927	86.12	86.88			86.50	113.29	106.47			109.88	104.04
23112 x 23212	89.63	86.82			88.23	109.60	108.84			109.22	103.97
23003	39.17	84.58	71.18	94.73	72.42	106.86	108.22	114.32	119.82	112.31	102.34
1904 x 1923	81.66	92.89			87.28	103.54	107.86			105.70	101.10
*Saginaw—Check	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
*White Blossom Dutch	112.84	111.40	114.88	121.00	115.03	99.05	96.09	91.21	88.52	93.72	99.05
*Blue Blossom Dutch	120.77	115.45			118.11	92.30	84.14			88.22	95.69
*Ottawa 829C	110.42	103.27			106.85	83.72	88.56			86.14	91.32
*Irish Pure Line No. 3	121.52	120.67	120.00	124.71	121.73	77.94	74.30	76.49	70.58	74.83	86.56
*Ottawa 770B	133.27	136.76			135.02	59.79	79.48			69.64	85.99
*Irish Pure Line No. 5	128.13	71.52			99.83	76.02	79.66			77.84	83.34

*Commercial Varieties.

In Table 1, the Saginaw variety is used as a standard or 100 per cent and the other varieties are measured in per cent yields of the standard. The percentages are calculated by straight line interpolation between the two nearest standard plats. There were 21 plats planted with Saginaw seed. The values in the last column are obtained as follows: Average per cent of seed x .25 plus average per cent of fiber x .75 equals the value.

Table 2.—Actual yields of seed and straw obtained in the test and calculated yields of fiber.

Variety	No. plats	Actual wt. seed pounds	Ave. wt. seed per plat	Actual wt. straw pounds	Ave. wt. straw per plat	Calculated wt. fiber pounds	Ave. wt. fiber per plat
23012	2	9.42	4.71	53.31	26.66	10.08	5.04
23111 x 23211	2	11.32	5.66	46.50	23.25	8.81	4.41
1805-21	2	10.46	5.23	48.37	24.19	9.43	4.72
Ottawa Longstem	2	13.91	6.96	43.12	21.56	8.35	4.18
1923 x 1927	2	9.94	4.97	48.87	24.44	8.49	4.25
23112 x 23212	2	9.94	4.97	47.87	23.94	8.51	4.26
23003	4	16.27	4.07	102.41	25.60	18.53	4.63
1904 x 1923	2	9.96	4.98	51.12	25.56	8.44	4.22
Saginaw—Check	21	118.51	5.64	442.09	21.05	87.55	4.17
White Blossom Dutch	4	27.31	6.83	77.50	19.38	15.45	3.86
Blue Blossom Dutch	2	14.50	7.25	35.12	17.56	7.11	3.56
Ottawa 829C	2	11.82	5.91	40.50	20.25	7.05	3.53
Irish Pure Line No. 3	4	27.03	6.76	71.87	17.97	13.53	3.38
Ottawa 770B	2	15.79	7.89	32.00	16.00	5.62	2.81
Irish Pure Line No. 5	2	11.55	5.78	36.49	18.25	7.17	3.59

THE CONFERENCE PEAR

A Variety Being Tested at the South Haven Station and Which Can Be Recommended For Home Use and For Limited Commercial Trial

STANLEY JOHNSTON, SOUTH HAVEN STATION

Among the numerous pear varieties being tested at the South Haven Experiment Station, the Conference is one of the most outstanding and apparently is worthy of thorough trial throughout those portions of the state where pears are commonly grown. This variety was introduced by

Fig. 2.—The Conference pear. The tree is a moderate grower and is very productive.

Thomas Rivers, the English Pomologist, in 1894. It is raised in considerable quantities at the present time in England, where it is very popular. Two trees were planted at South Haven in 1897 and since they began to bear fruit the variety has received favorable comment from time to time in the station reports on account of unusual productiveness and the fine quality of its fruit.

The tree is a moderate grower and very productive. On the station grounds it has never failed to set a full crop of fruit year after year. Limited experimental work indicates that it is an exceptionally good pollenizer for Bartlett and a number of other standard varieties. At South Haven the trees have never blighted although this does not indicate that the variety is immuned to blight. However, the type of growth which the tree makes is rather short and hard, suggesting that it probably has considerable resistance to blight.

The fruit is medium to above in size, typically pyriform, although somewhat variable in shape; the skin is shining green, dotted and overlaid in varying amounts with russet; the stem is long and woody; the flesh is pale yellow with a slight pinkish tinge, melting, very juicy, sweet; the quality is very good. In appearance, the fruit is not quite so attractive as might be desired. If the fruit had a golden russet color instead of a greenish russet, the variety would surpass the Bosc, its nearest rival, in most respects, especially in earliness of bearing and productiveness of tree. However, its appearance is as good or better than that of many other commercial pear varieties.

The harvesting season of the Conference, as grown at South Haven, is about the middle of September, usually a few days ahead of the Bosc. The fruit becomes edible sooner than the Bosc and will not keep as long, although it may be held for a considerable time in cold storage.

Thus far, apparently, it has not been propagated and catalogued by American nurserymen. During the past two years, however, the Experiment Station has propagated a few trees for distribution for trial purposes and now one or two nurseries are propagating it in a limited way. It can be recommended both for home use and for limited commercial trial.

THE DUNBAR EXPERIMENT STATION FOREST

Located in the Upper Peninsula of the State It Is Being Used For Research and Demonstrational Purposes

A. K. CHITTENDEN, FORESTRY SECTION

The tract of approximately 577 acres, known as the Dunbar School lands, located in Chippewa County, about 16 miles south of Sault Ste. Marie, and acquired by the Michigan State College in 1925, is being used for forestry and agricultural research work. One hundred and twenty acres are in farm land and the rest is forest or cut-over land. The forest consists of two

general types: first, a mixed stand of spruce and balsam with some white pine and cedar, and second, a hardwood type consisting of more or less mature broadleaf trees native to the region. There are also gradations between these two major types.

No serious fires have occurred on the tract for over twenty years and as a result there is excellent reproduction of evergreens throughout the softwood type. Some of the softwoods are now of marketable size. In places the forest is in need of thinning, and the hardwood timber is needed for fuel on the farm. There is a market in Sault Ste. Marie for all timber that may be cut.

The forest will be maintained for experimental and demonstration purposes, yielding approximately an equal supply of wood annually and it will be managed on a business basis. The object is to show the returns that can be obtained from a forest of this type and to determine the best methods of management. As occasion requires, land now in fields may be used for forestry and some of the reclaimed swamp land may be used for agriculture.

The principal product will be spruce and balsam pulpwood, for which there is a steady market. For the time being, mixed hardwoods, such as maple, birch, and oak will be of next importance. During the first few years, no large hardwood timber will be marketed, all the cutting in the hardwood types being in the nature of improvement cuttings, the product to be largely fire-wood which can be used on the farm. Later, however, sufficient fuel-wood should be available from thinnings and branchwood, so that the mature hardwoods can be put to better use.

In time, white pine, by planting and natural seeding, should surpass the hardwoods in importance, furnishing boxboard material and better products. White cedar will always find a ready market as posts and poles. The Balm of Gilead and other popples of sufficient size which occur in the temporary types may be sold for excelsior bolts.

The climax type in this region on the loamy sand, characteristic of the tract, is the maple-birch association. The true ultimate climax stands probably consist of sugar maple, yellow birch, and American elm. The mature hardwood forest is indicative of this condition, although even here the black ash, red maple, and softwoods still occur, the survivors of past plant associations.

Fortunately, much of the tract is still in the softwood stage, although large areas already show the invasion of the sturdier hardwoods forming forests of the hardwood-softwood type. Near the shore the red oak is waging a losing fight with maple and birch; oak here is far north of its optimum. Balm of Gilead, tamarack, alder, willow, black spruce, red maple, and black ash are all in the primary succession that will be eliminated if nature has her way before the climax is reached. Secondary successions have been initiated by fire and logging which in many cases have given rise to temporary types such as aspen and herbaceous growths. These, too, will disappear as the forest slowly progresses toward the climax type.

The balance of nature is very fine so that various causes may easily modify many of the site factors and thus prevent further progress toward the climax type. It is possible by the application of silviculture to prevent further invasion of the more commercially valuable softwoods by the climax and subclimax hardwoods. Red maple and birch are two hardwood invaders that usually appear first. Cutting these out and favoring the softwoods, should keep the latter the predominant species.

Of the softwoods the species of principal value are white pine and white spruce. The white pine has become a negligible factor in the forest owing to the heavy logging of this species and the resultant scarcity of reproduction due to meager seed supply. It seems likely, however, that other factors are operating, as the almost total absence of white pine reproduction cannot be attributed entirely to the lack of seed trees, for even where these occur there is little reproduction. The white pines that are present are worthless for lumber and will be left in the hope that white pine reproduction may be secured.

Another important problem is the evident excellent condition for the reproduction of balsam fir as compared to the condition for spruce. This is due to several factors: (1) In the past logging operations balsam, because of its low value, was not as closely utilized as spruce. This increased the proportion of balsam in the stand and hence its seeding potentialities. (2) Balsam is a much more prolific seeder than spruce. Given the same number of seed trees, balsam will produce many times the seed that spruce will, more than offsetting the greater viability of spruce seed. (3) Balsam prefers a shady site for reproduction, whereas spruce seedlings cannot stand the same amount of shade. It also seems that on this rather moist tract spruce prefers a more mineral soil for germination than does balsam.

Cutting balsam to a lower diameter limit than spruce, will materially decrease the number of seed trees. If spruce is given preference in cleanings and thinnings a larger per cent of the reproduction should survive. The intermediate cuttings tend to open up the stand letting in more sunlight which should also favor the more intolerant spruce. Logging operations, by stirring up the soil, should produce a seed bed more favorable to spruce. For these reasons the percentage of spruce in the future stands should be greater than at present.

White cedar makes very satisfactory growth in this locality if not suppressed; though its growth is not quite as rapid as that of balsam, its much higher commercial value would suggest that it be favored over it. Whereever cedar is found it should be encouraged as it is the only valuable species which will reach merchantable size in the shade of other trees. An overstory of spruce with a partial understory of white cedar can be secured and will give the highest returns for the site.

Black spruce should be removed in favor of white spruce, but not for balsam, as growth studies indicate that black spruce growth is very satisfactory here and will give a greater money return than balsam, although it will not grow as fast.

In the hardwood types the softwoods present should be favored, although no attempt should be made to have the softwoods assume the principal role. The sugar maple and yellow birch are the most valuable of the hardwoods and should receive preference over the others. Red maple is the least valuable.

In the mixed hardwood-softwood type the softwoods should be given every possible chance to develop. Hardwoods do not produce as much timber per acre and are not as valuable per unit of measure.

Of the temporary species, the Balm of Gilead might be developed into a permanent crop tree. It may be possible to get cuttings of this species to grow on the river flat or swamp types. In the swamp types the present worthless growth will be gradually removed and ash, cedar, black spruce, and Balm of Gilead tried as a crop.

The aspen type will be cut to merchantability wherever possible, but the small aspen in this type will not be cleared off as it is an excellent nurse tree for the reproduction of more valuable species. Reproduction by planting, where necessary, will be secured before all the bare land that needs planting has been covered.

It is desired to keep the tract in a mixed, selection type forest, consisting of the most valuable species possible; to increase the amount of timber per acre by the growing of tolerant and intolerant trees together; to obtain reproduction by natural seeding so far as possible and to plant up the openings and to underplant where natural reproduction is not secured within three years after cutting.

The selection system will be used in the permanent types. Temporary types may be clear cut, limited only by merchantability and the necessary shade and protection for the reproduction and the site. Planting operations will aim at securing a mixed stand rather than a pure even-aged stand of any one species. Improvement cuttings, thinnings, cleanings, etc., are to be carried on in conjunction with the main operations.

Under the selection system the oldest, largest, diseased or defective trees are to be removed. In order to maintain the forest as a mixed forest, however, it will be necessary to consider each species separately and to establish a cutting standard for each. Thus in the softwood type if the balsam is present in larger numbers but is smaller than the white pine and spruce, the latter should not be cut so heavily or the forest will become a pure balsam stand. In order to increase the percentage of white pine, only badly suppressed or diseased trees of this species will be cut during the first few years. Any merchantable hemlock will be removed. Healthy white spruce under 10 inches in diameter will be left standing. Balsam fir and white cedar may be cut to eight inches in diameter when merchantable and the black spruce to nine inches in diameter. These diameter limits are stated merely as an indication. The condition of the forest will govern all cuttings.

Twenty acres of stump land were planted to white pine and fir this year. Two methods of planting were used; the furrow method and planting in holes. The furrow method has so far given the better results.

It will be several years before the forest is in a going condition, but meanwhile a number of sample plots have been laid out and studies will be made of the growth and behavior of various species of trees under different conditions of soil and management.

EQUIPMENT FOR EXCAVATING MARL

A Mobile Outfit Developed at This Station Which is Being Used the Third Season With Considerable Success

H. H. MUSSELMAN, AGRICULTURAL ENGINEERING SECTION

The marl excavating equipment developed by the Agricultural Engineering Section of this station is being used the third season with considerable success. Demonstrations have been made for two seasons and through the experience thus gained, where it has been necessary to operate under a variety of conditions, many suggestions for improvement have come. A brief description of the special bucket and the method of rigging or setting up the outfit is given for those who may not have had opportunity to set it in operation.

Marl, it may be briefly explained, is a calcium carbonate deposit laid down under marshes, along the shores and in the bottoms of lakes. It will vary in thickness from 1 to 15 feet or more the variation often occuring in different parts of each deposit. The fact that it is found in lakes and marshes indicates that marl is usually saturated with water and in many cases lies entirely below the water level.

Character of Marl

Marl is of about the same composition as lime, containing in some cases more clay or organic matter which reduces its purity as calcium carbonate. It is slightly heavier than water for an equal volume, as taken from the deposit. In physical characteristics it is puttylike and sticky when wet and easily disintegrates to a powder when thoroughly dry. It is difficult, however, to air-dry a large mass of it so that it can be reduced to a powder although it may be easily broken up.

Marl may be used very satisfactorily in place of lime. The conditions under which it must be handled make it difficult to adapt to agricultural purposes, and it was for this reason that experimental work on digging and

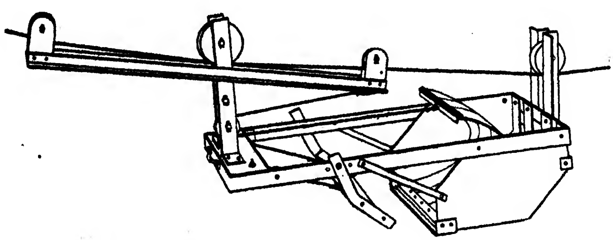

Fig. 3.—This drawing shows the construction of marl digging bucket.

applying to the soil was undertaken. These experiments have resulted in the design and use of a special digging bucket and method of using.

The Special Bucket

1. With the special bucket the marl is peeled or sliced in a layer whose thickness is partly determined by a depth gauge. The depth gauge prevents digging in and excessive pulls in loading.
2. Slicing also makes it unnecessary to lift the bucket and load and to overcome suction in loading.
3. The flexible lining of the bucket makes unloading absolutely perfect even with the stickiest material.
4. Points of heavy pulls are reduced to a minimum by the design of the bucket.
5. A design, which reduces hard pulls in loading and unloading, reduces the anchorage necessary, an important factor especially when anchors must be set in the lake bottom or in the marsh.
6. Reduction of pulls also reduces the maximum power required and consequently the strength of hoisting and cable equipment.

Size and Capacity

Buckets of 1/5 cubic yard, 1/3 cubic yard, and 1/2 cubic yard capacity have been tried. Where an 8 H.P. engine is to be used with a light hoist the 1/5 yard bucket is recommended and this should have under favorable conditions a capacity of 30 to 50 cubic yards per day. The 1/3 yard bucket is the most satisfactory size and is adapted to use with the small tractor and a 1,500 pound line pull capacity hoist. The outfit should take out from 40 to 75 cubic yards per day. The 1/2 yard bucket requires a large hoist and a 25 H.P. or larger tractor. Though this has not been extensively tried, its capacity is estimated at from 60 to 120 cubic yards per day. For the smallest size buckets a 1000-pound line pull capacity double drum hoist having a line speed of 150 to 200 feet per minute is used. For the medium and large size buckets a line pull capacity of 1,500 pounds and 2,000 pounds respectively, with a line speed of 150 to 200 feet per minute is required. On all hoists it is desirable to have the return drum on the hoist of larger diameter than the load drum so that a higher speed may be used in returning the bucket to the point of loading.

Mobility of the Outfit

Equipment for operating the 1/5 or 1/3 cubic yard capacity bucket may be readily moved from one marl deposit to another, since the equipment is not prohibitive in weight, and the anchorage required is not too large a problem. The mobility of the equipment is an important factor since it makes possible the use of the equipment over a large area, thereby increasing the length of operating season. A mobile outfit, making possible a large number of set-ups, also reduces the hauling distance required to get the marl on the land.

Cost of Operation

Allowing for depreciation, repairs, and operating costs, marl may be dug for 50c per cubic yard figured on an air-dry basis, where 500 yards or

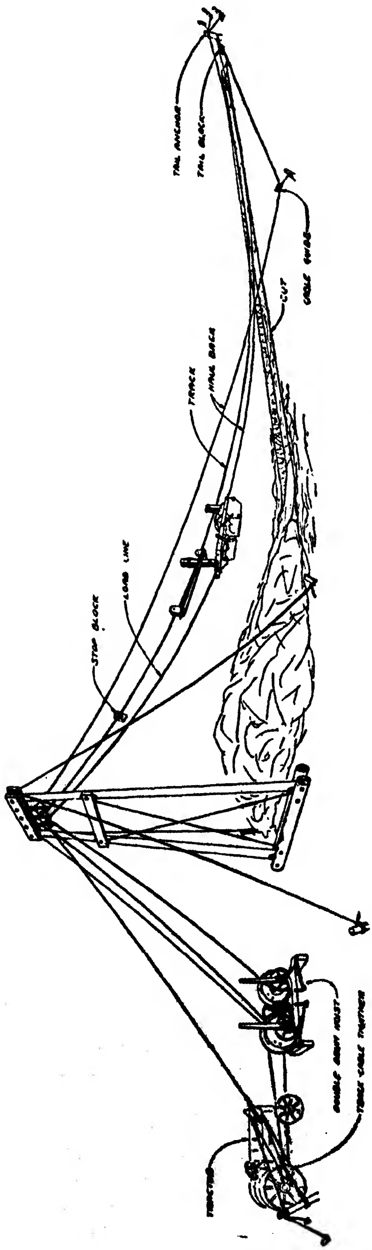

Fig. 4.—This drawing shows the set-up of marl digging equipment.

more are taken out at one set up and the operating season is of reasonable length. A shrinkage of as high as 25 per cent in drying may be expected. The cost figures given will of course vary with the size of outfit, operating conditions, and the skill and experience of the operator.

Plans Are Furnished

Blue print plans showing, to scale, the construction of the special bucket and set-up in the accompanying cut are furnished free of charge. Dimensions necessary for construction may be secured from these drawings. The set-up blue print shows the hoist, mast, anchorage, pulleys, and methods of rigging the cable. Additional information may be had from the Agricultural Engineering Section, Michigan State College, East Lansing, Michigan.

Operation

An adjustable track cableway is used to carry the bucket. This cableway is adjusted in height, at intervals, by means of a block and tackle or a fence stretcher, as found necessary. The load line is attached to the front of the bucket and is reeved through a pulley on the mast to the load drums on the hoist. The return line is run from the rear of the bucket through a pulley at the tail anchor, thence through a guide pulley at some distance back from the trench, thence through a pulley at the mast to the load drum. Both load and return drum should be equipped with brakes. In operation the bucket in position to load is pulled forward, the cutter separates the slice of marl which, as the cutter goes under it, pushes the lining of the bucket back in position. When the bucket is filled it stops cutting. It is then carried to the dump in the track cable. The push rod in coming in contact with a stop block on the track cable ceases to move with the bucket, which action causes the loose end of the belt lining of the bucket to be pulled forward, thus rolling the marl out of the forward end of the bucket.

Fig. 5.—Showing bucket unloading.

Removal of Overburden

Since the bucket follows one path, a trench the width of the bucket, will be cut. Where muck overlays the marl, it must be removed; this can be done with the bucket. By piling close to the mast and spreading level, the muck forms a good base for the pile of marl. Fifty per cent straight nitroglycerine dynamite may be used in removing the overburden if time must be saved. It is fired by the propagation method, placing the detonating cap, preferably fired electrically, in one stick of dynamite which is placed in the middle of the row of sticks forming the line to be opened.

Drying Marl

In summer the marl should be allowed to drain and dry for a period of two weeks before using. Unless too much clay is present it should crumble readily. It is believed that if the stock pile of marl is allowed to stand through the winter, the action of frost will assist to some extent in disintegrating it. However, in large stock piles this probably does not affect the marl to a depth of more than 18 inches to 2 feet.

Spreading

Thus far the use of the manure spreader has been found the most satisfactory method of spreading. The method is to place a thin layer of straw in the spreader to prevent the marl working through the spreader in hauling, and to load the spreader level, perhaps not more than 1/2 to 2/3 full to get the desired amount per acre. For long hauls the spreader is not suitable and the marl hauled in wagons or sleighs is placed in small piles in the field if it is to be spread by hand, or at the end of the field if the spreader is to be used. Weathering in small piles for a considerable period puts the marl in a good spreading condition.

Amounts to Apply

Since marl cannot be put in as good mechanical condition as lime for spreading, it is necessary to apply a larger amount for immediate effect, although a larger amount of calcium carbonate is applied thereby. Where one ton of limestone is to be used per acre at least one and one-quarter cubic yards of marl with more than 90 per cent calcium carbonate should be used to secure the equivalent amount of calcium carbonate. On account of difficulty in securing an even spread and the variability of marl in percentage of calcium carbonate, from 3 to 5 yards of marl should be used on soil requiring two tons of ground limestone per acre.

OBSERVATIONS ON THE MICHIGAN SEPTIC TANK

Examination of One Tank in Operation Since 1915 and Another Since 1918 Indicates the Design of the Tank to be Satisfactory

O. E. ROBEY, AGRICULTURAL ENGINEERING SECTION

Of the large number of septic tanks built as demonstrations, but few have reported any trouble. Recently, however, trouble was reported in two of the Michigan type septic tanks located in St. Clair county and these were among the first constructed. One was built in the spring of 1915, the other in the fall of 1918. They were examined May 6, 1926, and observations made of the causes of trouble and their general condition.

The tanks have been in continuous operation since they were built, taking care of all the sewage from ordinary farm homes provided with pressure tank systems of water supply and complete bathroom equipment. One was located about 25 feet from the house and about 18 inches under the surface. The tile system consisted of about 210 feet of tile with cemented joints running through an orchard and 100 feet of tile without cemented joints about 18 inches deep. The tile system of the other tank consisted of 25 feet of sewer pipe with cemented joints and two lines of 4-inch drain tile of 100 feet each. Both tile lines were laid in rather heavy clay; in the second case the clay was not very well drained. These lines were from 12″ to 16″ below the surface.

The apparent cause of the trouble in each case was the rusting off of the 3/8″ rods supporting the jar of the siphon. This had caused the jar to settle down and close the siphon discharge pipe. The siphon chamber then filled up until the effluent discharged through the overflow tile, making a continuous flow tank. Since the ground under the tile field was heavy, it apparently soon became clogged from the continuous flow of sewage. The experience with this tank would seem to indicate that a continuous flow tank on heavy ground is very unreliable.

One thing was very noticeable, on examining the first chambers of the tanks: they were functioning perfectly. Although the tanks had not been cleaned since they were installed only a small amount of sludge had accumulated—about one foot. One tank had a normal scum on the surface; the other, built in 1915, had practically no scum.

The observations made on these two tanks confirm the statement that a septic tank will work satisfactorily when near the surface, and that the tile system may be shallow even under somewhat adverse conditions. Furthermore the design of the tank seems satisfactory, and with a more durable siphon which has been devised, the tank should be very durable and require little attention.

DANGERS FROM POISONOUS GASES IN SILO FILLING

To Prevent Accidents, the Blower Should Be Started For a Few Minutes Before the Workers Enter the Silo

F. W. FABIAN, BACTERIOLOGICAL SECTION

At first thought, about the only danger which might arise in connection with filling a silo would be in falling off the silo, or into it, fracturing one or more bones or doing other bodily damage. However, every year casualties are reported—and sometimes death results—from asphyxiation or smothering of the workers by carbon dioxide gas arising from fermentation. Carbon dioxide gas is not a poison *per se* or injurious in dilute amounts such as ordinarily occur, in fact, it has been found that a 6 per cent concentration exists in the air sacs of the lungs. Furthermore carbon dioxide is thought to be essential for normal respiration. It is being used with oxygen in artificial respiration for the resuscitation of drowning persons and in cases of severe electric shock. Hence, it is only under special conditions that it may prove dangerous; as for example, when it completely excludes oxygen or replaces it to such a point that the tissues of the body suffer. This condition may arise in silo filling.

The following is quoted from an article in the September, 1925, number of Hygeia:

"Numerous studies on ensilage have shown that the green fodder on being placed in the silo immediately begins to undergo changes opposite to normal plant metabolism; i. e., the oxygen of the surrounding air is consumed and carbon dioxide gas liberated. In some cases the oxygen is almost entirely consumed. The carbon dioxide surrounding the particles of ensilage is supposed to be the principal preservative of the green fodder. Because of the high specific gravity of carbon dioxide, it tends to remain at the surface of the ensilage and for a few feet above."

Records show that most of the silo accidents occur in the morning, apparently after fermentation has taken place during the night or over Sunday. On entering a partially filled silo in the morning, therefore, the workmen may be engulfed in an invisible lake of carbon dioxide gas. The danger, of course, is greater if the worker lies or sits on the surface before the filling operations begin.

To prevent accidents, if the silo is partly filled with fresh fodder, the blower should always be started for a few minutes before the workers enter. Information concerning the simple rules for preventing accidents should be more widely disseminated among farmers and dairymen.

CULTURED MILK AS A MEDICINAL AGENT

Lactobacillus Acidophilus and Acidophilus Milk

G. L. A. RUEHLE, BACTERIOLOGICAL SECTION

Acidophilus milk is now used as a medicinal food by a large number of people, especially in the larger cities where the material is available. The fact that people are willing to pay as high as $1.00 per quart for the preparation puts it either in the ranks of true medicinal agents or one of the fads of the day.

Why drink acidophilus milk? To answer this question one must go back to the time of Metchnikoff the great Russian zoologist who first introduced the idea to the world. Metchnikoff noticed that among the Bulgarian people there were a large number who lived to be very old. In looking about for the reason for this he made a study of their food and discovered that they consumed large quanities of a soured milk called Yoghurt. This soured milk contained a rod-shaped bacterium which was named *Bacillus bulgaricus* in honor of the Bulgarians. This organism produces a much larger amount of acid in milk than does *Streptococcus lactis* which is the organism usually responsible for the souring of milk. Metchnikoff thought that the reason people grow old is that on an ordinary diet there is a great deal of putrefaction in the large intestine. According to the theory this results in the production of poisonous chemical products which are absorbed and supposed to cause hardening of the arteries and all of the other evidences of old age. He believed that if sour milk were consumed the intestinal putrefaction could be prevented and thus old age delayed. His reasoning was not bad from the bacteriological standpoint since it is known from laboratory experiments that the putrefactive bacteria cannot grow in the presence of very much acid. Furthermore, the souring of milk is ordinarily sufficient for the prevention of putrefaction.

Metchnikoff believed that the *Bacillus bulgaricus* would be able to acclimatize itself to growth in the intestinal tract and hence would be the logical microbe to implant there. As a result of his studies and theories, a great many people took cultures of *Bacillus bulgaricus* in the form of milk soured by the organism or as tablets or powders in the hope of delaying old age or of preventing the so-called (but incorrectly) autointoxication or intestinal intoxication which is a condition resulting from excessive putrefaction in the intestines.

Considerable benefit was obtained in some cases but in others none resulted. Many laboratory workers claimed that they had demonstrated implantation of the organism in the intestinal tract while others were unable to observe any permanent change. After a great deal of research work it was finally established that *Bacillus bulgaricus* is not able to establish itself permanently in the intestines of humans and some other animals but that

Lactobacillus acidophilus, which is very similar in appearance to *Bacillus bulgaricus* and is a normal inhabitant of the intestines of many animals and of some human beings, is able permanently to establish itself if properly nourished. This proper nourishment consists of supplying carbohydrate food to the large intestine. The microorganism is able to utilize a large number of carbohydrates as a source of energy but practically only those are useful which are not completely digested and absorbed in the upper portions of the intestinal tract and hence can get down to the colon. In the class of carbohydrates useful for this purpose are included raw starch, dextrin, and lactose (or milk sugar). These facts explain why the early workers sometimes obtained successful results with feeding milk containing *Bacillus bulgaricus.* The milk furnished food for *Lactobacillus acidophilus* and since the latter looks just like *Bacillus bulgaricus,* it was easy to conclude that *Bacillus bulgaricus* has been implanted when as a matter of fact, *Lactobacillus acidophilus* had been stimulated to abundant growth. The numerous failures are also accounted for by these facts. If there were none of these microorganisms present in the intestine, they obviously could not be made to grow even if the proper food were present. Or if small numbers were added in tablets and powders but no carbohydrate food reached the colon no growth would result. This last is a principle which must be borne in mind in all attempts to change the intestinal flora. To effect a permanent change the colon must be constantly bathed with a suitable carbohydrate in solution or suspension to furnish food for the microorganism. If little or no carbohydrate reaches the colon but an abundance of protein does, then the flora of the colon must inevitably be putrefactive in nature. On the other hand, if the substances reaching the colon contain sufficient amounts and a constant flow of carbohydrate material the flora will usually become non-putrefactive. Many people are able to change their intestinal flora by simply drinking large quantities of milk (containing lactose naturally or by additions) or eating several ounces of lactose, or lacto-dextrin per day. Unfortunately there seem to be others who must be supplied with the proper microorganism from outside sources. These are the cases who should benefit by drinking acidophilus milk.

The reader may be interested to know how acidophilus milk is prepared and to know why it is more costly than sweet milk or buttermilk although made of the comparatively cheap skim milk

In the first place, the preparation of the acidophilus milk requires rigid bacteriological control in order to get successful results. The microorganism concerned must be cultivated at body temperature which means that if the milk is not free or nearly free from certain of the micro-organisms, usually present in milk, it will be spoiled by an abnormal fermentation because the bacteria causing the abnormal fermentations grow best at body temperature. Usually manufacturers attempt complete sterilization of the milk before adding the *Lactobacillus acidophilus* and this is usually recommended by laboratory workers. This, however, results in a brown colored, astringent tasting product. It has been made in small quantities in the Bacteriology Laboratory of Michigan State College and in larger quantities in the College Dairy without resorting to complete sterilization. The product has a much less disagreeable flavor and is only slightly browned. The milk is heated to 205° F. —210° F. for 1—1½ hours, after which it is cooled to 105° F. and inoculated at once with 0.5 per cent of a pure culture starter of *Lactobacillus acidophilus.* Only the purest, freshest skim milk obtainable is used because any other

milk will result almost inevitably in abnormal fermentations. The inoculated milk is incubated at 105° F.—95° F. until it is coagulated. This usually requires about 20 hours, when the cultured milk is in the form of a soft, homogeneous jelly with a clean, mild acid flavor. The acid present is lactic acid. The curdled milk is agitated until it has the consistency of buttermilk. It is then bottled and refrigerated until sold, although there is some question as to the desirability of refrigeration.

The pure culture starter mentioned in the preceding paragraph is prepared from a smaller pure culture starter (about 1/3 ounce). Both of these pure culture starters are carried along from day to day by the bacteriologist. They must be kept pure, that is, they must consist of one species of bacteria only (*Lactobacillus acidophilus*). It is necessary that new strains be isolated every few months as the old strains gradually lose their property of becoming acclimatized to the colon.

With the above description of the process of manufacture in mind, coupled with the further fact that the volume of the sales is small, the reader will readily understand that the price must be high.

The product has been on sale at the College Dairy and in several drug stores in Lansing, being manufactured by the College Dairy with the advice of the Bacteriology Section. The latter also cares for the pure cultures and occasionally isolates new cultures. The Bacteriology Section has been dispensing small lots of this cultured milk for several years.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, Agricultural Experiment Station, East Lansing, Michigan.

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258 Insects of Field Crops.
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264 Second Report of Grade Dairy Herd.
267 Michigan Weeds (only to libraries and teachers).
273 Utilization of Muck Lands.
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281 Trees, Shrubs and Plants for Farm and Home Planting.
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MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN

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MACHINERY AND CORN BORER CONTROL

Old and New Methods Used in Clean-Up Work—Destruction of Trash Necessary

H. H. MUSSELMAN, AGRICULTURAL ENGINEERING SECTION

Among the many means which are being tried for the control of the European corn borer, the development of machinery is making considerable progress. It must not be concluded, however, that these developments give promise of anything like complete success or that any vigilance of efforts in any other direction can be relaxed. The menace is too near at hand in Michigan and of too serious a nature for any compromise measures to be used.

In the program of control, the complete disposal of all stalks and stubble is one of the first requirements. In the future, it will be necessary for corn growers to follow a practice of cleaning up farms and fields with a thoroughness that at the present time can scarcely be imagined. It is in this program of thorough cleaning up that mechanical devices may be of assistance.

Among the mechanical devices adapted to this purpose and one which should be widely applicable is the low cutting attachment for the corn binder. This is being furnished as an attachment which can be applied to both new and older models of corn binders. The device consists essentially of a set of knives, guards, carrying frame, bell crank, pitman bearings, together with braces and fastenings for attaching to the lower part of the framework of the binder. The drive is arranged to be taken from the pitman which drives the original knife. In at least one design, the knife frame is made to float on the ground to prevent cutting beneath the surface. The low cutting device is designed to cut the stalks at a height of two inches or less, which reduces to a negligible factor the number of corn borers left in the stalks. Doubtless, due to the severe conditions under which the low cutting device works, it will be found necessary to keep replacement and repair parts on hand, since, the silage cutting program depends to a large degree on this attachment.

The stubble beater is a new machine which operates on the principle of the hammer feed mill. A horizontal shaft has loosely hung on it a large ...r of strips of steel which rotate with the shaft. The shaft and steel ... are driven from the power take off on the tractor, and are run at a high speed. The shaft and revolving knives are carried on a framework ...ch has wheels set far enough apart to cover two rows. The work is done

at ordinary tractor speed and the stubble is torn to shreds to the level of the ground by the rapidly revolving knives.

This machine would be applicable in practice to conditions where corn is cut by hand as well as where cut with the binder. It would not interfere in any way with the harvesting program, and work with it could be done at any convenient time between harvest and the following spring. Its cost of operation has not been determined under farm conditions but should not exceed one dollar per acre including operating and overhead costs.

The husker shredder should also prove an effective machine in destroying the borer. Its usefulness lies in the fact that it may be used to dispose of practically all stalks not ensiled. With proper management, it need not increase the cost of harvesting.

Doubtless the most important machine in Michigan, because of the great interest in dairying, is the silage cutter. Silage when cut in ½-inch lengths offers little opportunity for the borer. The use of the silage cutter is common and no new program or practice is necessary where it is used except to make use of the low cutting device or other means of destroying the stubble.

In addition to the above machines, deep plowing which thoroughly turns and covers all trash, may prove to be of considerable importance. To assist in thoroughly covering the stubble, a steel rail may be drawn over them while the ground is frozen. The cutting box and roughage mill or alfalfa grinder have also been suggested for stalk disposal although it appears that their adoption may be quite limited.

THE USE OF ELECTRICITY ON FARMS

Experimental Line to Demonstrate Central Station Current For Rural Power and Light

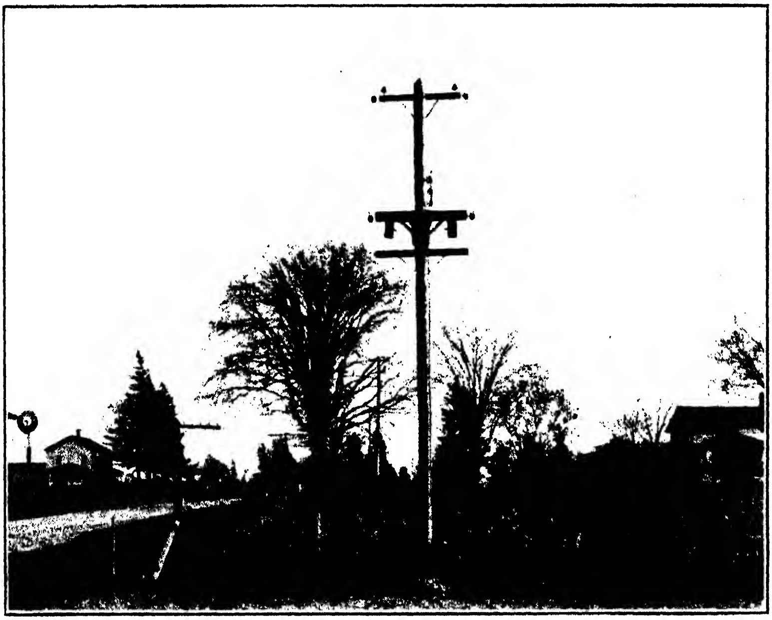
H. J. GALLAGHER, ENGINEERING EXPERIMENT STATION

A few years ago the possibility of the use of electric energy in many of our farm homes was a question that was seldom considered, but a few years in this era of development cause many changes.

In the early development of electricity, direct current was all that was used. Direct current could not be transmitted any great distance, and so the use of electricity was confined generally within the limits of the city. With the development of alternating current, which is now used, it becomes possible to transmit electric energy great distances, and transmission lines go beyond city limits and connect with other cities and villages. Transmission lines, in a great network, pass through thousands of miles of agricultural communities to unite thousands of cities and villages. These trans-

mission lines make it possible for a great many farmers to use electric energy.

The farmers near these transmission lines want electric energy; they want to know how to get it; they want to know they can use it after they do get it; they want to know how the use of electricity is going to fit into their farming operations; and they want to know what returns they can reasonably expect in actual dollars and cents on their investment in wiring and equipment. They want an idea on other values of electricity which are not measured in dollars and cents, such as making farm life more pleasant,



Type of Power Line Giving Service to Farmers.

eliminating the drudgery of household labor, and helping with the farm chores.

The question is being asked in thousands of farm homes in every section of the country, "What part can electricity play on the farm and in the farm home?"

The state colleges in some twenty states are endeavoring to answer these questions by conducting research and experimental work on farms having electric energy. The Michigan State College is interested in answering these questions for Michigan farmers, and the college is studying an eight-mile transmission line in the agricultural community between Mason and Dansville to find how electricity can be best used on Michigan farms and to determine how farmers are going to be able to get electricity.

Dansville Community Representative

The Dansville community was selected because it is representative of Michigan Agriculture. It is also on good roads, and will be near a transmission line where the community will be able to get electric service much cheaper than would be possible in a community where a line was built especially for the farmer's use.

This transmission line is to be a 5,000 volt line, constructed by the Consumers Power Company, which is co-operating with the college in this study. The Consumers Power Company have filed a rate with the State Public Utility Commission that will apply only to this particular line. This rate is one that will enable the farmer to use a quantity of current at a very reasonable figure. Any farmer within 150 feet of the transmission line is entitled to electric service on this plan. For this service, he pays a fixed monthly charge of $3.00, which is an insurance to the Power Company of some return on the money it has invested in supplying the farmer with service. In addition to the $3.00 per month, the farmer pays 5c per kilowatt hour for the first 30 kilowatt hour's energy, and a flat 3c per kilowatt hour for all energy over 30 kilowatt hours regardless of the connected load or of how he uses it. Farmers who live some distance from the transmission line cannot use this plan at the present time. The expense in supplying them with energy would be much greater due to additional poles and wires.

This rate is an experimental rate and will form a basis on which rural rates may be established.

The farmers on a rural transmission line built especially for them will necessarily have to pay a higher service charge than neighbors living nearer a transmission line that is carrying current between cities and towns. Just how much more he will have to pay is one of the problems we are attempting to solve.

If the Power Companies knew how much electric energy an agricultural community could be expected to use, they could easily determine what the costs on different types of lines would be. They do not know, however, and they are interested in finding out, and so the Consumers Power Company, the State College, and the farmers on the test lines have all united to establish a school right on the farms and in the farm homes where the results of using electricity under everyday conditions will be studied. From the things we learn in this electrified farm school, we hope to be able to determine: (1) a standard basis on which a great many farming communities will be able to get electric service; (2) what it will cost them; and (3) what they can use it for on the farm and in the farm home.

National Committee at Work

A national committee on Rural Electrification represented by the American Farm Bureau Federation, the National Electric Light Association, the Power Farming Association, the American Society of Agricultural Engineers, the United States Department of Agriculture, the United States Department of Commerce, and the United States Department of the Interior is co-operating with different states working on Rural Electrification.

The National Committee has made provisions with manufacturing companies to provide various types of household and power equipment on a loan basis to the college which will enable each farmer on the line to have this equipment in his home or barn for a period of three months. All loaned

equipment will be separately metered so the farmers on the test lines will know definitely the cost of each operation. All the information obtained by using equipment on different farms and under different conditions will be published so that anyone interested in rural electrification will be better able to determine how various equipment will fit into their farming operations.

In addition to studying the electrical equipment now on the market, considerable research work in using electricity in new ways will be carried out. It may be that there is a better way to cook on the farm with electricity than by using the stove now manufactured, or it may be that the pumping of water, or the cooling of milk can be simplified. It may be that much of the equipment now on the farm can be operated with electricity. These are some of the research problems that are to be studied.

Generally speaking, it may be said that electricity will lessen the work and increase the comforts of the home.

It will supply light, pump water, run the washing machine, the vacuum cleaner, the refrigerator, the fan and the sewing machine, heat the electric range, the electric iron, the toaster, and the percolater, and operate the great variety of other household devices to which it is now applied.

Electricity Will Do Much

It will light the barns and other buildings, milk the cows, separate the cream, run the churn, cool the milk, pump water for the stock, cut ensilage and elevate it into the silo, operate a threshing machine, fanning mill, potato grader, buzz saw, and work shop machinery and appliances, charge radio and motor car batteries, and perform a wide variety of other services of this kind.

In performing these tasks, it not only lightens the work immeasurably; but makes it possible for one operator to increase very greatly the amount of work he turns out.

The saving of time and work is of increasing importance on the farm because it is becoming much more difficult and much more expensive to hire farm labor than it was a few years ago. Whatever will effect this economy of time and labor is worth studying as a profitable investment. After all, this is by no means the only consideration. Whatever saves time and work makes for better and happier living conditions. Drudgery and monotony need no longer be tolerated. Electricity is a practical means of helping to banish them from the farm.

The range of household appliances and farm machinery which can be operated by electricity is large, and is increasing. No one who is considering the use of electric power for these purposes should be dismayed by the thought that a complete equipment need be purchased at one time. The farmer buys his mowing machine, reaper, separator, and milking machine one by one, and not as a group. The same course may well be followed in buying electrical apparatus, except in the case of wiring system, which should be purchased as a unit.

This line is now under construction, and it is planned that the delegations of people who annually visit the Michigan State College will be able to visit this line, to talk with the farmers who are using electricity, and see what they are doing with it; so that, if the opportunity comes in the future when they can get electric energy, they will have a better appreciation of its use and worth.

CHOOSING A HOME ELECTRIC LIGHTING PLANT

Factors To Be Considered Include Adaptation to Individual Needs—Types Built to Suit All Conditions

F. E. FOGLE, AGRICULTURAL ENGINEERING SECTION

A generation ago, electrical development and the use of electrical energy was of little concern to the farmer. The last decade has marked the advent of an increased use of electricity in farm homes and farm work. About three per cent of the farms in the United States have central station electric service. The improvement of the electric light bulb, the development of the storage battery, the standardization of the small gas engine, and their application to farm electric light plants have made the small private plant available to the farmer. Increased sales and competition have sufficiently lowered the cost of installation to bring it within the means of many farmers.

The farmer is very well aware of the uses to which electricity is put in cities and villages, and he generally recognizes the advantages of electricity for light and power, and the desirability of having it available for use.

Electricity may be secured for the farm in one of two ways: power company service or a private electric plant.

Farmers generally are interested in electric service from a power company on a basis of prices acceptable to both the farmer and the power company. Recognizing this fact a national committee was formed about four years ago, to study the relation of electricity to Agriculture. This committee is now actively at work.

A part of their statement of procedure is:

1. (A) How can service be supplied to the farmer and what is involved in its establishment.

(B) How can service be utilized by the farmer so that it will be profitable to him.

2. The purpose of this proposed work is to ascertain facts. No selfish propaganda of any interest or class involved shall be allowed to enter.

The committee consists of representatives from: The American Farm Bureau Federation, the National Grange, Individual Plant Manufacturers, the National Electric Light Association, American Society of Agricultural Engineers, United States Department of Agriculture, United States Department of Commerce, and United States Department of Interior. Further than this, twenty different states now have projects under way studying the problem of getting electricity to the farmer. Michigan is included in this number.

An authority, speaking of the efforts being made has said, "The convenience, safety, ease of control and general flexibility of electrical power are

such great arguments in its favor as to justify extreme efforts to extend its use generally to agriculture."

Whatever the outcome of these efforts may be, the fact remains that for a number of years to come, the private plant will be the only available source of electrical energy on the great majority of Michigan farms. While the cost of electricity from a private plant is, on the average, three to four times greater than the city user now pays, it is not excessive in view of benefits derived. Nor is it considered much higher than power companies must receive to bring current long distances into the country.

That many farmers are prospective purchasers of light plants is evidenced by the interest shown in plants at our annual Farmers' Day and Farmers' Week, and the number of letters received asking about the selection of a plant. Small electric light plants are not standardized, neither is the servicing of them uniform or satisfactory. The plant is a complicated outfit. The farmer often does not fully understand the storage battery, he is not familiar with electricity, and is not an expert judge of such a machine. This lack of knowledge makes selection of a plant seem difficult. It is true that even the trained engineer must depend upon the history and performance of a plant more than upon judgment.

Technical Terms Explained

In the discussion of electric lighting plants, certain technical terms will be used which should be understood in a general way.

The ampere is the unit used to measure the flow of current through a wire, just as the gallon is the unit used to measure the flow of water in pipes.

The volt is the unit used to measure the pressure which causes the flow of current, just as the pound is used to measure the pressure which causes water to flow through a pipe.

The watt is the unit used to measure the power of a current. It is the product of the amperes times the volts. For example: A flatiron consumes 550 watts of current. If the current furnished were 110 volts, 5 amperes would be used, or 5 amperes at 110 volts gives 550 watts.

The kilowatt which is a larger unit of measure is equal to 1,000 watts. Current is usually purchased from the power companies by the kilowatt hour which means using one kilowatt of current for one hour. The capacity of private plants is usually rated in kilowatts.

A 500 watt flatiron used for one hour would consume 500 watt hours of current or one-half a kilowatt. The average cost per kw. hour for current in cities is about ten cents. At this rate it would cost five cents per hour to operate a 500 watt flatiron. Ten 50 watt lights could be operated on the current required for such an iron.

The essential parts of a lighting plant are the generator and some form of power for driving it. The plant may or may not have a storage battery. The voltage of farm plants is nearly standard. Thirty-two and 110 being used almost exclusively. Thirty-two vosts is comparatively low and 32 volt plants are commonly spoken of as low voltage plants.

The battery plant is usually operated at 32 volts. A storage cell delivers approximately 2 volts and 16 cells are required with a 32 volt plant. A 110 volt plant would require 55 cells. This number of cells would be prohibitive

in price and for this reason the 110 volt plants are usually automatic and operate on a low voltage starting battery.

The power for driving the generator may be a gasoline engine, wind power, or water power. The gasoline engine is, up to the present time, the most commonly used.

There are three types of plants, when classified according to the method of connecting the power to the generator. The unit type, the semi-unit type, and the belted type.

In the unit type, the engine and generator are on the same shaft and are supported by two main bearings. This permits of good alignment and of automatic oiling of bearings. This type plant is compact and easy to keep clean. Plants of the unit type are usually of somewhat lighter construction. They may or may not be equipped with a power pulley.

Plants of the semi-unit type have the engine and generator on the same base, connected by a flexible joint. The engine and generator may be built by the same company but are usually assembled. This type plant is more accessible, the generator is not subjected to the engine vibration. Both the engine and the generator have two main bearings; this is desirable but necessitates more attention to oiling.

The belted type has the advantage of being accessible and simple. Local mechanics can, as a rule, give service on a gas engine or a simple generator. The belt, however, will need some attention. Nothing but a high grade gasoline engine with a throttle governor should be used to drive a generator.

There are at least four different makes of wind electric outfits on the market. These outfits are comparatively new, but have proved themselves to be practical. This method of driving a generator has many advantages and gives great promise for the future.

Something basically new in a wind driven plant has recently come to our attention. In place of the old style wind mill wheel, this new plant utilizes a two-blade aeroplane-type propeller. By its use, the weight is materially reduced. Also it offers less resistance to the air and consequently less strain on the derrick, and yet more power is obtained.

One user, speaking of the wind-electric outfit, said, "My problem is to use all the current generated and not how to generate enough for use."

Much has been said about driving the electric generator by water power. This is an entirely practical method where water power is available, and we should be pleased to give information on it if desired. Very few farms in Michigan have power available in sufficient quantities or near enough to warrant considering this type of power.

Storage Battery Types

There are two types of storage batteries: the lead acid type, and the nickel-iron. The latter is the Edison battery. The Edison cell is nearly fool proof, i. e., it cannot be overcharged or over discharged. But due to the high cost per cell, the low efficiency, and lower voltage per cell requiring more cells to make a battery of a given voltage, it is little used.

The lead acid type is the common storage battery. Each cell will deliver approximately 2 volts, i. e., a 32 volt battery would consist of 16 cells. From 60 to 70 per cent of the electrical energy put into a battery may be taken out, the balance is lost in the battery.

Storage batteries are rated in ampere hours, e. g., a 160 ampere hour

battery would be capable of giving 20 amperes of current for a period of 8 hours. Experience has proved that the larger size batteries are most economical. Nothing smaller than a 160 ampere hour battery based on a continuous eight-hour discharge rate can be recommended.

A high grade heavy plate lead battery has built into it approximately 300 full charges and discharges.

There are, on the market, plants using a battery and also those which do not. The latter are known as automatic plants. With this type plant, current is generated and sent directly out onto the line. A small automobile type battery of 12 to 24 volts is used for starting. The plant automatically starts whenever there is a demand for current on the line. The plant must always run when current is needed even though but one light is turned on.

This method does away with the loss of current in the storage battery and the high depreciation on the battery. As against this, it cannot be as efficient as a battery plant when operating on a small load. Such plants will render most economical service where the load is heavy and continuous.

A light plant having a storage battery to supply current for small uses, and so equipped that it would automatically start to generate when the heavier loads came on would be ideal for farm use. Some plants of this type are now on the market and others are sure to be brought out.

A question frequently asked is, "Which is the best electric lighting plant?"

This is an impossible question to answer just as it is impossible to say which automobile or which gasoline engine is best. All have good points, but some are better suited to certain conditions than others. It is not our purpose to say which type plant or what combination is best, but to point briefly, factors, to be considered, that the prospective purchaser may be better able to select a plant to fill his needs.

Determine Plant Size

One should first determine the size plant required. Plants are rated according to their kw. output. The total watts per day with time they are in use will form a basis for calculations. A plant having an output of from ¾ to 1½ kw. will fill the needs on the majority of farms. Farmers are more likely to err by purchasing too small a plant rather than one too large.

The voltage may next be determined. Thirty-two volt current can be carried about 200 feet without excessive loss of current or excessive cost for large copper wire to carry it. A 32 volt plant is satisfactory up to a current consumption of 2 kw. hours per day. At the present time, 32 volt bulbs and appliances may be purchased as readily as 110 volt.

The matter of service and repairs on a plant is worthy of careful consideration. The farmer must look to his local dealer for these items.

It goes without saying that one should purchase from a well established concern that is likely to continue in the business.

Whether one purchases a gasoline or wind, battery or non-battery plant will depend somewhat upon his conditions and requirements, but more upon personal choice.

It is well to purchase a plant that has been on the market and proven itself. If a plant has been on a competitive market long enough to become established and still sells for a higher price than some other plant, it is safe to conclude that superior design, materials, or workmanship make it worth more.

To summarize, the points to consider in the selection of an electric light plant are:

1. Determine size in kw. output of plant required.
2. Decide on most satisfactory voltage.
3. Select the type of plant that seems to suit your particular needs.
4. A belt pulley is desirable.
5. Purchase a plant that has proved itself and held its own against competition.
6. Get a plant made by a dependable, well established manufacturing concern.
7. A reasonable amount of service should go with a lighting plant. See that your agent is in the habit of following up his sales and that he has satisfied customers.
8. Central station service is almost invariably more satisfactory than a private plant both from the standpoint of cost and of service.
9. The cost of producing current by a private electric plant is discussed in the quarterly bulletin for May, 1921, page 119, "The Farm Electric Plant," also in the quarterly bulletin for May, 1926, page 196, "Fuel Costs of a Private Lighting Plant."

WOODLOT TAXATION IN MICHIGAN

Farmers Use New Exemption Act—Seen as Important in Michigan

KARL DRESSEL, FORESTRY SECTION

Woodland taxation is an integral part of the tax problem before the American people today. The tax burden is increasing rather than decreasing. In the last decade, taxes in Michigan have advanced on an average of 251 per cent. The woodlot tax problem is growing each year.

The State legislature realized some time ago the heavy tax burden placed upon the farm woodlot under the general property tax. In 1911 the Foster Act was passed to help relieve the situation. Only one woodlot owner is known to have taken advantage of this act due to a few unsatisfactory clauses. In 1917 the act was revised by the legislature and is now known as Act 86 of 1917, or the Woodlot Tax Act.

The requirements under the act are not strict nor do they impose undue burden upon the owner. They require just good woodlot management in keeping the woodlot fully stocked with small trees either natural or planted and exclusion of grazing. Both these requirements are for the good of the woodlot as they increase the amount of timber per acre. The act requires that a certain amount of land on the farm be devoted to agriculture per acre of woodlot and the property must be contiguous. This clause is to protect the taxing district so that the wild land of the township may not be classified

and thus reduce the taxable value to such an extent that it would injure the district.

In lieu of taxes, the woodlot owner under this act pays a five per cent cutting tax on the actual stumpage value of timber removed, except where it is to be used by the owner or his tenant. Under the act, the woodlot is valued at $1.00 per acre and taxed at the local rate each year, which makes the actual taxes very low.

In an investigation, it was found that 50 woodlot owners had taken advantage of this act up to 1925. They were as follows:

Allegan County	1	Lake County	1
Alpena County	1	Lapeer County	2
Antrim County	1	Leelanau County	2
Calhoun County	4	Mecosta County	1
Eaton County	1	Montcalm County	3
Emmet County	1	Muskegon County	3
Gratiot County	1	Newaygo County	1
Ingham County	5	Oceana County	10
Ionia County	5	Ottawa County	1
Isabella County	1	St. Joseph County	1
Jackson County	3	Van Buren County	1

The data and results of this investigation are from three sources: an inquiry to the owner, an inquiry to the supervisor of the township, and an actual field visit to the county treasurer's office where the township tax records are kept. In some cases, it was not practicable to visit the county treasurer's office, and in such counties neither data nor conclusions are shown.

In Allegan County, one woodlot owner is listed under the woodlot act. He applied for tax reduction on his 20 acre woodlot January 10, 1922. The woodlot is a natural forest growth with trees from one to seventy-five years of age. The owner states in answer to an inquiry that the act has reduced his valuation.

The county treasurer's record shows the valuation on the farm and woodlot in 1921 to have been $8,700. After coming under the act, the valuation in 1922 was $7,200 or a reduction of $1,500. This valuation remained stationary from 1922 through 1924. The valuation of other landowners in this section remained stationary from 1921 through 1924, except for one who received an increase of $200. Thus this landowner received a reduction of $1,500 in valuation on a 20-acre woodlot, not only for one year but also for a number of years, and this should continue as long as the woodlot is left under the act.

In Ionia County, five landowners have filed applications for tax reduction on their woodlots. Of the five, four have been accepted and one rejected upon the owner's own request, as he wanted to wait.

One woodlot owner filed his application December 10, 1918, on a 20-acre woodlot. The woodlot consists of a natural forest growth with trees from seedlings to maturity. In answer to an inquiry, the owner stated that his valuation had been reduced.

The county treasurer's records show that the valuation on the farm and woodlot was $10,000 in 1918. After placing the woodlot under the act, the valuation was placed at $9,350, or a reduction of $650, or $32.50 per

acre of woodlot. From 1919 through 1924 the valuation remained stationary. A note and special entry is found on the township tax record which states that a $650 reduction in valuation is granted under Act 86 of 1917, and the 20 acre woodlot is listed and taxed separately at $20 for the whole acreage, or $1 per acre. The valuation of the other landowners of this section has remained stationary from 1918 through 1924. Thus this owner was the only one to receive a reduction in valuation.

Another landowner in Ionia County applied in 1924 for tax reduction on his woodlot. The woodlot consisted of ten acres of both natural and planted stock, ranging from seedlings to trees 60 years of age.

The records in the county treasurer's office show no reduction in valuation on this property through 1924, nor is there any note of such a forestry reserve on the township books. In an inquiry to the supervisor of the township, he states that it was certified to him too late to be placed on the tax roll for that year and the woodlot is acceptable under the act too late to be effective in 1924. Thus the effects of the act cannot be determined until after the 1925 assessment. All indications seem to be favorable, and there is little doubt that the valuation on this man's property will be reduced.

Another landowner applied March 1, 1925, for tax reduction on a 40-acre woodlot. The woodlot consists of a natural growth averaging about 15 years of age, with 1,200 trees per acre.

The tax records in the county treasurer's office fail to show that the supervisor ever accepted this woodlot under the act.

In an inquiry to the supervisor, he states that the application was rejected at the owner's request, as he wishes to investigate the matter a little more, and if the application is filed next year there is no reason why it will not be accepted.

Another landowner in Ionia County filed an application March 20, 1918, for tax reduction on his 32-acre woodlot. The woodlot consists of a natural hardwood growth ranging from seedlings to mature, merchantable trees.

In an inquiry to the owner he states that the act reduced his valuation but not enough.

The records in the county treasurer's office show that in 1918 the valuation on the farm and woodlot was $3,000. After applying under the woodlot tax act in 1919, the valuation was placed at $1,800. A reduction of $1,200 or $37.50 per acre of woodlot. From 1919 through 1924 the valuation of this property remained stationary.

The valuation of the other landowners of this same section remained stationary from 1918 through 1924 except one who received an increase in 1920. This landowner with the woodlot under the woodlot tax act was the only one in this section to receive a reduction in valuation from 1918 through 1924.

Another landowner in Ionia County filed his application for tax reduction on his woodlot April 4, 1921, on a nine-acre woodlot. The woodlot consists of a young natural growth of hardwoods.

In an inquiry to the owner he stated that the act reduced his valuation and is working out satisfactorily in his case.

The records in the county treasurer's office show the valuation on the farm and woodlot in 1920 was placed at $11,000. In 1921 after placing the woodlot under the tax reduction act the valuation was placed at $10,400, a reduction of $600 or $66.66 per acre of woodlot. From 1921 through 1923 this valuation remained stationary, and in 1924 another reduction of

$200 was granted. The woodlot is listed and taxed separately each year with a note to the effect that there is a $600 reduction under Act 86 of 1917.

The valuation of the other landowners of this section remained stationary from 1920 through 1924 except in the cases of two who received slight reductions, one in 1923 and the other in 1924, but both of these were very small in comparison to the one received by the owner of the listed woodlot.

In Eaton County, one woodlot owner applied for tax reduction on his woodlot in 1923. The woodlot consists of 40 acres of young natural forest growth.

The woodlot and farm are assessed as two separate descriptions. The woodlot was assessed at $2,000 in 1923 and was placed under the tax reduction act in 1923 and in 1924 the valuation was again placed at $2,000, but no taxes were charged against the property while in 1923 this same woodlot payed a total tax of $68.96. The tax records contain a statement that this 40-acre woodlot is under the tax reduction act.

The other part of the farm remained stationary in valuation from 1922 through 1925, as did the other land in this section. There is no doubt but that this woodlot owner received some very tangible benefits from Act 86 of 1917.

These cases are fair examples of the actual working out of the woodlot tax act as actually found upon the township tax rolls in the county treasurers' offices. In nearly every case the act was working out quite satisfactorily. In the few cases where the woodlot owner reported that he was not satisfied, it was invariably due to a misunderstanding either on his part or that of the supervisor.

There are many woodlots in the State that are eligible under the act, and yet the owners have failed to take advantage of it. The Department of Forestry of the Michigan State College will be glad to send a copy of the act and application blanks for listing lands to anyone interested.

STERILITY IN CATTLE SERIOUS PROBLEM

Disease Due to Varying Causes and Needs Skilled Treatment—Infected Animals Source of Danger

E. T. HALLMAN, ANIMAL PATHOLOGY SECTION

The correspondence we are receiving from breeders indicates that sterility in cattle is one of the most troublesome problems that face the breeder. In fact, we have more inquiries concerning this than any other disease of livestock. This article is not written with the idea of offering a solution of the problem, but is an attempt to discuss it in such a way that the breeder will have a better understanding of it.

Reproduction in the cow depends upon the mating with the male, each

having healthy and normally functioning reproductive organs, and of maintaining the health of the female organs throughout the period of pregnancy. It is complicated by the fact that reproduction is the result of the correlated functions of a group of organs of each sex, and the failure of one or more organs of either sex to function properly may prevent reproduction. The reproductive organs of both sexes are among the most complex and highly specialized organs of the body. There is no function that is more complicated or specialized than that of reproduction. It is a fundamental law that the more complex an organ is, or the more specialized its function is, the more susceptible it is to injury and the more difficult it is to correct the effect of injury. It is a fact that all disturbed functions and all diseases are due to direct or indirect injury of some kind.

Failure to breed in a cow is the result of absence of function or disturbed function of one or more of the reproductive organs of the cow or the bull. It is obvious, from the complexity of the problem, that in any specific case of sterility it may not be possible to determine what organ, or organs, is the cause of failure to reproduce. Or, if this can be determined, it may not be possible to determine the cause of the condition, or there may be no known method of correcting the trouble. To illustrate this last statement, it may be stated that sterility is occasionally due to failure of the ovary to develop the egg. The cause of this is unknown. Sterility is occasionally due to abscessation of one or both testicles of the bull. The cause of an abscess is very well understood but the treatment of an abscess of the testicle is far from satisfactory.

A great deal of work has been done by investigators in several experiment stations (including this one) and others on sterility and some progress has been made in methods of controlling it, but much yet remains to be learned before the problem can be effectively met.

Most of the research in this problem has been on the bacterial diseases of the reproductive organs, and considerable effort has been made to control the infections that cause sterility with a variable degree of success. The germ that causes abortion is often an important factor in sterility. Other germs similar to those that cause wound infections may invade the reproductive organs of either sex and spread from one animal to another through copulation and association, causing sterility.

Whether the condition in any particular herd is due to bacterial infection, can be determined only by the personal examination of the herd by a qualified veterinarian, or, as in the case of abortion disease infection, by a laboratory examination of the blood. If it can be determined that sterility is due to bacterial infection, there is very little, if anything, that the breeder can do in the treatment of the condition.

Before the treatment can be advised, each sterile animal must be examined in an attempt to determine the organ or organs diseased and the nature and extent of the disease. If the condition can be determined, it may be such that it cannot be remedied. If the condition is one that encourages treatment, the proper treatment may be medical or surgical or a combination of both. Treatment of the womb and ovaries must be based on ability to recognize disease of them and upon a knowledge of the action and limitations of drugs and the ability to use special instruments. This knowledge can be obtained only through intensive training and experience, and is not possessed by the breeder. There are no simple remedies for diseased conditions of the reproductive organs. They are not simple organs and when

they cease to function properly they may not yield to the most skilled efforts of the experienced veterinarian.

Statistics indicate that not more than 40 to 70 per cent of the animals sterile because of bacterial disease of the reproductive organs can be made to breed by proper treatment by a skilled veterinarian. If the services of a qualified veterinarian are available and the value of the herd is high, the results of treatment justify the expense incurred. In grade herds, it may be questionable whether the results justify the expense of treatment. In such herds, the owner naturally asks if there is not something of value he can do. For cows in which sterility is due to ovarian or uterine trouble, there is no specific treatment he can give that is likely to be beneficial, and improper or misdirected treatment may actually do harm. If the disease is limited to the vagina, vaginal douching three or four times a week may be of value. The selection of a proper douche is of great importance. The lining of the vagina is quite sensitive to irritating drugs or strong solutions of disinfectants, and their use may aggravate the condition. One-half pound of borax to a gallon and a half of water is as effective a vaginal douche as any preparation that can be safely used by the layman.

The importance of nutrition as a factor in sterility is not definitely known. It has been assumed that rations deficient in certain minerals and vitamines were causes of sterility. This assumption is probably correct, but the minimum state of nutrition compatible with reproduction is not known, and it is difficult to evaluate this factor as a cause of sterility in animals fed the usual farm rations.

Lack of exercise and inadequate nutrition may possibly influence the herd resistance to bacterial causes of sterility. The owner of a herd in which sterility is a problem should carefully analyze his system of management and correct any practice that may be an important factor. A well balanced ration with a maximum use of legume pastures and legume hay, adequate exercise, and maximum exposure to sunlight are important factors in growing and maintaining healthy herds and are also of importance in overcoming disease. Cows with retained afterbirths or with bad discharges from the vagina should be handled in such a way as to minimize the danger of infection reaching other cows in the herd or the bull. A bull with an abnormal discharge from his sheath should not be used as long as such discharge persists. A bull with a low breeding efficiency record should always be considered a potential danger to cows he may serve. Low breeding efficiency in the bull may be due to over-use or to disease of his reproductive organs. A bull with diseased organs may be potent at times and impotent at others due to variations in the state of activity of the disease process.

THE SCIENCE OF MAKING SAUERKRAUT

Care Needed to Exclude Undesirable Bacteria From Kraut—Home-made Starter May Be Used

F. W. FABIAN, BACTERIOLOGICAL SECTION

Sauerkraut is a common article of diet. Wherever cabbage is grown, there one usually finds sauerkraut. It is a simple and convenient way of preserving cabbage. While almost everyone who raises cabbage makes sauerkraut, not all that is made turns out good. Often much is thrown out on account of spoilage, and much that is eaten should be thrown out due to its off-flavor.

Rules for Making "Kraut"

Only sound, firm heads should be used. The outer leaves should be removed and the cabbage cored. It should be piled in a clean place and shredded, and then it should be packed in a thoroughly cleaned container and salted. The usual proportion of salt added is two and one-half per cent, by weight. This may vary. Salt plays a very important part in sauerkraut making. It keeps down the undesirable micro-organisms and permits the desirable ones to grow. It also draws out the soluble food from the cabbage cells by osmosis, so that bacteria have plenty of food. The salt also "seasons" the kraut, so that it has an agreeable taste if properly made. Pressure must be applied to the cabbage during fermentation to press out the juices containing the food and to exclude air. During fermentation, the sauerkraut should be kept at a temperature of 80° F. for the best results. If the cabbage is cold when shredded, the temperature should be raised to 80° F. After fermentation ceases, the finished product should be sealed air tight.

The Bacteriology of Sauerkraut

If the few simple rules just given are followed, a highly desirable product should result. The reason for this is that the changing of cabbage into sauerkraut is a bacteriological process, and when one has surrounded the bacteria with ideal conditions they respond accordingly. The salt suppresses the growth of almost all bacteria except the group which produces lactic acid. They convert the sugars and mannite which are present in the cabbage into lactic acid, carbon dioxide, and ethyl alcohol. It is the lactic acid which is desired. This acid preserves the cabbage from putrefactive bacteria. Some alcohol is produced but not enough to keep the most rabid prohibitionist from eating sauerkraut. If not enough salt is added, bacteria other than the lactic acid group, get the upper-hand and a sauerkraut with an off-flavor results. Some of the bacteria causing this change are *Bacillus coli* and those that produce butyric acid. Both of these groups are very undesirable and

cause disagreeable odors and flavors. Another factor controlling bacteria is temperature. That is the reason why the temperature should be raised to 80° F. and kept there. If it is kept too low, then the undesirable bacteria grow. Keeping out the air by pressure also excludes undesirable bacteria.

Use of A Starter

The writer has had very good success with securing the desirable flavor in sauerkraut by using a home-made starter prepared as follows: Shred one large head or several small heads of cabbage and add two and one-half per cent by weight of salt. Place at 80° F. in a clean suitable container properly weighted. Allow to ferment several days. At the end of this time you can tell whether the sauerkraut will have the desired flavor or not. If it has not, throw out and prepare a new batch. Keep doing this until the desired flavor is obtained. When you have the desired flavor in the small batch, which we shall call the starter, proceed to make the large batch and inoculate it with the starter by adding some at different intervals as the container is being filled. One gallon of starter is sufficient for about 25 gallons of cabbage. The value of using a starter is that you don't take any chances on the flavor of your sauerkraut. The starter serves to inoculate the sauerkraut with the right kind of bacteria so the outcome will be assured. This has worked very successfully and can be recommended. If one neighbor has a batch of sauerkraut that suits your taste, a gallon or so of the liquid may be used for inoculating a new batch.

Why Sauerkraut Spoils

It is the acid produced by bacteria that preserves the kraut, just as vinegar is added to pickles as a preservative. In vinegar we have acetic acid while in sauerkraut we have mostly lactic acid which is more pleasing to the taste. If any thing happens to destroy the acid, putrefactive bacteria flourish and they putrefy or rot the sauerkraut. There are certain yeasts as the *Mycoderma* that eat up the acid and thus bring about just such a condition as described. That is the reason for sealing the sauerkraut air tight after the fermentation has ceased. The *Mycoderma* require air to grow and if the air is excluded then they can't grow and use up the acid. Air may be excluded by canning the sauerkraut or putting melted paraffin on top of the container.

Discoloration of Sauerkraut

Sometimes a pink color is seen on sauerkraut. This is due to wild yeasts, *Torulae,* growing in abundance on it. The yeasts use up the water and turn an otherwise desirable product into an undesirable one.

A brown discoloration is sometimes noted in kraut. This is due to an enzyme and occurs after the kraut has been removed from the vat or barrel. If you desire kraut that is light in color, it should not be cured so long. The longer it is cured the darker it gets.

SPRAYING FOR SCAB CONTROL

Results of Experiments with Concentration of Materials—Quantity of Spray Used Important

W. C. DUTTON, HORTICULTURAL SECTION

The grower of apples has many factors to consider in choosing a material desirable for use in the control of apple scab. Since the primary purpose of spraying is to control the diseases and insects that affect the trees or fruit, it is obvious that the material must be effective (in this instance, in the control of scab). Other points are that it should not cause serious foliage injury or russeting of the fruit when used alone or in combination with other materials. After fairly satisfactory materials have been found for use in insect and disease control, there is still the question as to the best strength or concentrations to use in order to obtain satisfactory control without causing unnecessary injuries to the fruit or foliage.

The problem can be stated in three or four specific questions. Will spraying materials used at strengths weaker than generally recommended give satisfactory control? Will increased strength insure better control? Is there danger of overspraying? Which is best, a light application of strong material, a heavy application of weak, or a moderate application of medium strength material?

An effort was made to answer these questions in an experiment recently completed.* The variety used was Hubbardston and the trees were twelve

Materials:—Two materials, lime-sulphur and bordeaux, were used. Lead arsenate was added for all applications, except the "prepink." Both were used at two strengths which are called *weak* and *strong*. The weak bordeaux was a 2-4-100 mixture plus 1 pound lead arsenate, and the strong was a 6-12-100 mixture plus 3 pounds lead arsenate. In the weak lime-sulphur, 1½ gallons of the concentrate was used to make 100 gallons of spray. To this was added 1½ pounds lead arsenate. The strong lime-sulphur solution was made by using 3 gallons of the concentrate to make 100 gallons of spray to which was added 3 pounds of lead arsenate for insect control.

Rates of Application:—Each material at both strengths was applied at three different rates, which are termed *light, moderate* and *heavy* applications. The syraying was done in such a way that trees sprayed with a

*A complete report of this experiment is presented in Tech. Bul. No. 76, Agri. Exper. Sta. Mich. State College, and will be sent upon request.

year sold. The season was very favorable for the development of scab, foliage injury, and russeting of the fruit. These conditions, coupled with a proper schedule and careful timing of the applications, gave a thorough test of all the methods that were employed.

moderate application received twice as much dilute material as those lightly sprayed and where heavily sprayed the dosage was three times as great as with the light application. Lime-sulphur also was used at a medium strength, 2½ gallons in 100, and was applied at the moderate rate.

It will be seen that two conditions were introduced which would affect results. The first is the strength of the material and second, the rate of application. A third factor is introduced when the first two are considered together and it is this which determines the amount of *active ingredients* that are applied under each treatment. For instance, in the moderate application of weak lime-sulphur twice the amount of active ingredients was applied to a tree as when the tree was given a light application, since just double the amount of dilute material was used. In like manner, the heavy dosage gave three times as much of active ingredients. By carrying this further, it will be seen that the heavy dosage of strong lime-sulphur gave six times as much of active ingredients as the first treatment because the strength was doubled and the application tripled. The same general relations hold with the bordeaux.

Results

Without presenting detailed figures, the results may be summarized as follows:

Weak materials are less effective than strong, when the rate of application is uniform. A light application of weak lime-sulphur was less effective than a light dosage of strong. Corresponding statements may be made regarding the moderate and heavy applications though the differences were less as the dosage was increased.

The rate of application also definitely affected results. A moderate application of weak lime-sulphur gave better results than the light and a heavy dosage gave still better results. The same was true with the strong lime-sulphur though the differences between the various dosages were much less than with the weak material.

Similarly, there was a close correlation between the amounts of active ingredients applied and the control of scab. For instance, comparing the moderate application of weak and the light application of strong lime-sulphur; both contained the same amounts of active ingredients but the dosage of dilute material was only half as great with the strong. The control of scab was about the same. With the moderate applications of both, that is with the dosage equal, the amount of active ingredients was as two to one, and this doubling resulted in a marked reduction in the amount of scab.

The results of this investigation show clearly that after a suitable spray schedule is once worked out and timely applications of good spray materials are made, efficient control still depends on two factors—coverage and concentration. Increasing the concentration of the material does not fully compensate for poor coverage nor will perfect coverage give satisfactory control if the concentration is too dilute.

It does not pay to save materials by over-diluting them with water; it does not pay to save time or compensate for careless application by putting more chemicals in the spray tank. Undersyraying may take the form of applying too weak materials or of not covering all surfaces. In either case control is unsatisfactory. Over-spraying, whether it takes the form of

drenching the tree or simply of coating it with a surplus of materials, is wasteful. A middle course which gives good coverage with a moderately concentrated material yields best results.

THE LARGER NARCISSUS BULB-FLY

Quarantine Forces Nation to Depend Upon Domestic Bulbs—State May Rank High in Production

EUGENIA MC DANIEL, ENTOMOLOGICAL SECTION

Now that the florists of the United States are dependent upon their own resources for bulbs of all kinds, a new problem has arisen in bulb culture, and as a part of this problem, the necessity for exact information concerning the insect enemies of bulbs.

Experience has proved that it is possible for Michigan to rank high among the bulb producing states and to-day a good acreage is devoted to this profitable industry. In view of these facts, growers and fanciers of bulbs will be interested to know that the larva of the "Larger Narcissus Bulb-fly," *Merodon equestris* was found this year, for the first time, in Michigan bulbs.

The mature stage of this insect is a very active fly, about the size of a honey bee. The head, thorax and anterior part of the abdomen of the "Larger Narcissus Bulb-fly" is black, the tip of the abdomen being clothed with light-brown hairs, making the creature resemble a very small bumble-bee. There is but one brood a year at this latitude. The adults are present over a period of about two months, which accounts for the variation in the size of the maggots or grubs found throughout the growing season. The first adults appear early in the summer and are present well into the fall. They are especially active on bright, warm days when the female may be found hovering over the bulb fields.

The eggs are laid on the plant, usually on the bulb itself, and the little maggot when it hatches, eats its way into the inside of the bulb where it feeds until full grown. It is rare for a maggot to desert one bulb and seek another. The first adult flies appear and deposit their eggs just at the time the bulbs begin to grow. The eggs hatch in about a week and the small larvae begin feeding. They feed until well into November when the full grown individuals become sluggish and practically stop eating.

Normally, the species winters over as a larva within the bulb, pupation taking place in the soil early in the spring, usually just above the bulb in which the larva has fed the previous summer. The mature larva is a grub-like creature, light grey in color, measuring from one-half to three-fourths of an inch in length and is more than twice as long as broad. The segmentation is quite distinct, the dorsal or top portion of the maggot is humped or rounded and the ventral or under portion is flattened. In general, the

creature reminds one strongly of the immature stage of the ox-bot or grub in the back of cattle which is all too well known.

The pupa is similar in appearance to the larva but is dark grayish brown in color, with decided segmentations. The damage to the bulbs of course is done in the larval or grub stage, for it is only in this stage that the insect can feed on the bulb. The bulbs of Narcissus, Paper Whites, Daffodils, Jonquils, Chinese Narcissus and Amaryllis are all said to be liable to infestation.

It is difficult to detect infested bulbs, especially when the larva is small. After the larva has developed to any considerable size, the bulb appears "soft," and later the bulb may deteriorate. "Soft bulbs" should always be under suspicion.

Two methods of control are at present in use, one of which is appended, viz;—the hot-water treatment. The carbon disulphide treatment which may be used profitably in large plants, involves the use of a vacuum tank in which a fairly high vacuum can be maintained. Both of these treatments are fully described in a publication of the Federal Horticultural Board. "Notice of Quarantine No. 62." U. S. D. A.

Directions for carrying on the hot-water treatment, are appended.

The Hot-Water Treatment for Bulb Flies and Eelworms

This treatment involves the submersion of the bulbs in wire baskets, slat boxes, or other containers, in water ranging in temperature from 110 to 111.5° F. for a period of not less than two and one-half hours. The range of temperature during this period shall not fall below 110° and for the safety of the bulbs should not exceed 111.5° F. In order that all bulbs may be exposed to the same temperature, the water should be agitated or circulated during the period of treatment so that a uniform temperature is maintained throughout the sterilization tank. To prevent heating of the bulbs following the treatment, it is desirable that they be plunged into or syringed with cold water promptly on removal from the sterilizer. Bulbs which are not intended for immediate planting should be dried by some means, mechanical or otherwise, before storage or shipment.

CONTROL OF MARKET MILK SOLD BY A MICHIGAN DAIRY 1922-1925

BY L. H. COOLEDGE,* BACTERIOLOGICAL SECTION

During the past three years a rather close check has been kept upon the bacteriological condition of the milk supply of a milk plant in a city of 3,000. The sanitary condition of raw milk arriving at the plant from neighboring farms has been determined by means of the pH score** as developed by Cooledge and Wyant (1) of this station. The bacteriological counts of the raw milk furnished to patrons of the plant have been determined by standard methods of plating. At times Milk Powder agar A (2) has been substituted for standard agar. This would make little difference in the results as a whole. Pasteurized milk made from the raw milk mentioned above as coming from neighboring dairy farms, and a chocolated drink made from the pasteurized milk have been checked by plating methods. An occasional check of the efficiency of the pasteurizing process has been made by the pH method described by Cooledge (3).

Though some of the results obtained during the course of this study are about what might be expected, other phases of the work are of such interest as to justify their presentation here.

The condition of the various milks studied during the course of this work was tabulated but the inclusion of the date here would require too much space. The samples of raw market milk, pasteurized milk and chocolate milk having counts of 10,000 or less and the samples of raw milk received from the farms and having a pH score of 70 or better are placed in a class as milk in a very unusual sanitary condition, and are recorded in Table No. 1.

Raw Market Milk

Raw market milk as sold by the dairy farm which is operated in connection with this milk plant is produced under conditions meant to be easily duplicated at the ordinary dairy farm. No expensive buildings or equipment are considered necessary. It is the aim to produce a good clean milk under such conditions that certainty exists that it is an excellent product at all times.

In studying the results of plating the raw milk during 1922, 1923, and 1924, the average bacteriological counts of 15,200, 19,800, and 73,000 were obtained. During this period samples were taken and plated as follows: 1922, 51 times; 1923, 8 times, and 1924, 113 times. The percentage of

*Deceased.

**This is a technical method of testing milk for its keeping quality. The ability of the milk souring bacteria to produce acid is measured by testing for the production of acid or for a change in hydrogen ion concentration when a small amount of the milk is inoculated into a sterilized broth, containing an indicator. The latter is a chemical which changes color when the acidity changes. The change in color is compared with a standard broth of known hydrogen ion concentration and of standardized color.

Table No. I.—Percentage of samples in very unusual sanitary condition.

Raw milk to patrons			Raw milk from farms			Past. milk to patrons			Choc. milk	Month
1922	1923	1924	1922	1923	1924	1922	1923	1924	1924	
66.0	....	....	94.0	85.2	66.6	14.0	....	....	....	Jan. 65.1
33.0	....	100.0	77.5	84.0	88.8	....	....	100.0	33.0	Feb. 73.7
50.0	....	14.0	81.6	82.1	60.7	....	....	86.0	50.0	Mar. 60.6
66.0	33.0	59.0	75.2	84.0	75.0	50.0	50.0	92.0	66.0	Apr. 65.0
33.0	.0	66.0	43.9	82.1	67.8	75.0	50.0	100.0	43.0	May 56.0
50.0	.0	60.0	53.0	48.2	25.9	....	.0	64.0	37.0	June 37.4
....	.0	58.0	39.0	28.6	19.2	....	83.0	64.0	55.0	July 43.3
....	....	54.0	20.0	51.0	73.0	....	100.0	83.0	73.0	Aug. 64.8
....	.0	23.0	62.7	73.9	88.8	....	....	83.0	55.0	Sept. 55.2
....	.0	55.0	81.5	75.0	82.1	....	100.0	90.0	75.0	Oct. 69.8
....	.0	82.0	....	85.3	73.0	0.0	....	92.0	66.0	Nov. 56.9
....	100.0	86.0	....	60.0	83.3	100.0	....	100.0	57.0	Dec. 83.7
49.0	19.0	59.7	62.8	68.9	67.4	40.0	64.0	83.0	54.5	Aver.

samples with counts of 10,000 bacteria per cc. or less during 1922, 1923, and 1924 were 49.0 per cent, 19.0 per cent and 59.7 per cent. The high average count of 73,000 during 1924 was due to a few high counts bringing up the average and not to a general slump in the sanitary condition of the milk. This is indicated by the fact that in 1924 over 59 per cent of the raw milk samples tested had bacteriological counts of 10,000 or less.

The unsatisfactory condition of the raw market milk during 1923 as indicated by the fact that only 19 per cent of the samples tested had counts of 10,000 bacteria per cc. or less, is explained by the management of the dairy as being due to the difficulty of keeping good help during that period. It is a certainty that low count raw milk can only be produced by careful, conscientious workers.

Results obtained upon the raw market milk during the three-year period are characterized by a lack of uniformity. This may be traced in many cases to a lack of efficient help as suggested above. At times high counts are traced to utensils with which the milk comes in contact. Failure to cool the Sunday milk because of a desire to be away early also resulted in high counts, as might be expected.

Raw Milk From Patrons

The raw supply intended for pasteurization and skimming is received from farmers in the neighborhood of the plant. This milk is brought to the dairy each morning in trucks. During the greater part of the year it arrives in good condition. During the summer months the sanitary condition of the milk reaches low ebb. This is the time when the weather is the hottest and when the farmer is the busiest with the work of the farm.

The method used in testing the raw milk coming from the farms has been the pH method mentioned before. This test measures the activity of the bacteria and enzymes present so that the results obtained indicate what the bacteria present are going to be able to do to the milk rather than being an attempt to give the approximate number of bacteria present.

Previous to the time that this test was started the milk from the farms

had been used in experiments by Cooledge and Goodwin (4) in which prizes were given in an attempt to encourage more sanitary methods of production.

During part of 1922 some of the raw milk considered in our tables, figured in a second study by Cooledge and Goodwin (5) in which milk was paid for on a quality basis. The pH test was again used in grading.

The average pH score of raw milk from the farms during 1922, 1923, and 1924 was 74.7, 76.0, and 76.3. During this time samples were taken from farm milk as follows: 1922, 1131 farms; 1923, 354 farms, and during 1924, 443 farms. The percentage of samples with scores of 70 or better during 1922, 1923, and 1924 were 62.8, 68.9, and 67.4.

During the 1921 milk contest, the milk from farms had an average score during the preliminary period of 73. The score during the contest proper was 78 in spite of much warmer weather.

The raw milk records may be tabulated for comparison as follows:

1921 Milk Contest	Score
Preliminary period, 3-7-21 to 4-1-21	73.0
Contest proper, 4-7-21 to 5-12-21	78.0
1922 Paying for milk on a quality basis 6½ Summer months	72.7
1922 Average for entire year	74.7
1923 Average pH score for year	76.0
1924 Average pH score for year	76.3

Pasteurized Milk to Patrons

The pasteurized milk furnished to patrons of the dairy is the treated raw milk which was considered under a previous head. Pasteurization as it is carried out at the dairy consists of heating the milk to a temperature of 145° F. and holding at that temperature for 30 minutes. This holding period is followed by immediate cooling.

During 1923 the method devised by the writer (3) for checking the efficiency of the pasteurizing process was used in this work. It was found that bacterial contamination was coming largely from the cooler and that it was difficult to avoid by the methods being used. Hot water was being allowed to run over the cooler and steam was applied with a steam hose.

Five determinations were made using this system of sterilization of cooler and pipes and five determinations in which a steam hose was connected with the cooler in such a way that the steam would flow through the pipes of the cooling and heating units. In this way the pipes of the pasteurizer were kept steaming hot until it was necessary to start the actual pasteurizing process. The results of these tests are tabulated below:

Average result (5 runs) of treating pipes by old method:

	Bact. per cc.	Per cent reduction in count
Raw milk	368,000	
From pasteurizer	4,580	98.75
Going to patrons	4,820	98.69
Return from route	5,840	98.41

Average result (5 runs) of treating pipes by new method:

	Bact. per cc.	Per cent reduction in count
Raw milk	282,000	
From pasteurizer	1,920	99.3
Going to patrons	2,160	99.23
Return from route	2,380	99.15

The greater bacterial reduction when the pipes of the pasteurizer were connected up in such a manner that steam could be allowed to flow through them cannot be denied. It happened however that after this system had been used for a couple of months that a leak appeared in the pipes of the cooler. It was thought that this leak might be due to expansion and contraction of the metal of the cooler it not being built for such sudden changes in temperature as result when steam flows suddenly into its tubes.

This leak was repaired and the cooler has given over six months of continuous service during much of which time steam has been used as in the new method of treating tubes of cooler. Care should be taken that scale is removed at least every two months as it accumulates readily when steam and brine have access.

The fact that the bacteriological counts of the pasteurized milk are in the neighborhood of 100 per cent lower when the new method of sterilizing the pipes of the cooler is used would seem to justify an attempt to find a cooler which is so constructed that the contraction and expansion due to sudden change in temperature could do no harm. It seems very probable that such a cooler can be found.

The average bacteriological counts of pasteurized milk during 1922, 1923, and 1924 was 11,800; 42,400 and 29,700. During this time samples of pasteurized milk were taken for counts as follows: 1922, 24 times; 1923, 20 times, and during 1924, 108 times. The percentage of samples with counts of 10,000 or less during 1922, 1923, and 1924 were 40, 64, and 83. We consider this a very good showing for pasteurized milk.

The higher average counts during 1923 and 1924 were due to several high individual counts bringing up the average during those years. The greater percentage of samples with counts of 10,000 or less during the two latter years indicate a great improvement in the pasteurized product as a whole.

Chocolate Milk

During 1924 a cholocate product was made by adding cholocate syrup to the regular pasteurized milk. At times the bacteriological counts on this product were very satisfactory but they were subject to wide fluctuations. High counts were usually to be accounted for by some carelessness of those responsible for the product. Pasteurized milk used easily became re-contaminated, syrup often had high counts due to long slow cooling that really amounted to an incubation period. In one instance, too much chocolate milk was made up and instead of being thrown out was sold over a period of several days. The last sold had a count well over 50,000,000 bacteria per cc. The average bacteriological count of the chocolate milk during 1924 was 22,000,000 bacteria per cc. During this time 89 samples were taken and counts made. The percentage of samples with counts of 10,000 bacteria per cc. or less was 54.5.

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(1) Cooledge, L. H. and Wyant, R. W. "The Keeping Quality of Milk as Judged by the Colorimetric Hydrogen Ion Determination." Jour. Dairy Science, Vol. III, No. 2, pp. 156-166, March, 1920.

(2) Ayers, S. Henry and Mudge, Courtland S. "Milk-Powder Agar for the Determination of Bacteria in Milk." Jour. Bact. Vol. 5, pp. 565-588. 1920.

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RELATION OF SOIL TO PLANT CELL SAP

Use of Fertilizers Lowers Freezing Point of Cell Sap—Phosphorus Content of Plant Affected*

M. M. MC COOL, SOILS SECTION

It has long been known that several environmental factors may affect the composition of crops. It is well recognized that additional information is needed on the relationships that exist between soils and plants growing upon them. We have been engaged in studying these relationships for several years. The writer and C. E. Millar showed the concentration of juices of several crops to be affected by several factors, soil fertilization being a very important one. Where an acid peat, Miami silt loam, and Plainfield sand were fertilized at the rate of 170 pounds of a 3-10-4 commercial fertilizer applied in the hill the freezing point lowerings of corn grown on the fertilizer and unfertilized soils were as given in Table No. 1.

Table 1.—Effect of fertilizers on the concentration of the sap of young corn plants.

Soil	Unfertilized freezing point lowerings °C.	Fertilized freezing point lowerings °C.
Plainfield sand	0.627	0.907
Miami silt loam	0.525	0.668
Acid peat	0.430	0.634

These data bring out that the sap of the corn plants grown on a soil that has received fertilizer has a greater osmotic pressure or greater concentration than it has when grown on unfertilized soil. Inasmuch as young corn

*The majority of the crops used in these studies were taken from Soil Fertility plots in charge of Dr. P. M. Harmer. Credit is due J. D. Romaine and C. M. Weldon for making numerous determinations.

plants are sometimes frozen in Michigan this difference in the freezing point that results from fertilization will frequently prevent frost injury. Additional crops respond in a similar manner, wheat, especially in its early stages of growth.

The writer and P. M. Harmer found a definite relationship between the sugar content of sugar beets and the fertilizer used on muck soils. By proper fertilization, it was shown that the sugar content of beets grown in such soils can be raised materially, and likewise the purity may be greatly improved. Later on Harmer and Weidemann brought out that the sugar content in the juices of several root crops and onions is increased and the quality likewise improved by fertilization.

Much additional study has been devoted to the juices of different crops. The freezing point lowerings of the sap of sugar beets is greatly increased by fertilizer when they are grown on muck soils. The results obtained from this crop grown on Chandlers muck are as given in Table 2.

Table 2.—The effect of fertilizer on the concentration of the cell sap of sugar beets. Muck soil.

Treatment*	Freezing point lowerings °C.
K 500	1.613
P 750, K 500	1.588
P 750	1.280
No treatment	1.403
N 300, P 750, K 500	1.600

*N—Ammonium sulfate; P—Acid phosphate; K—Muriate of potash

Similar results were obtained for this crop when grown on other muck soils. It should be noted, however, that the concentration of the juice of the sugar beet varies widely when grown on different muck soils. This crop is also affected in this respect when it is grown on mineral soils that are deficient in available plant food. Where it was grown on Miami silt loam, the results obtained are as given in Table 3.

Table 3.—The effect of fertilizer on the concentration of the cell sap of sugar beets. Miami silt loam.

Treatment	Freezing point lowerings °C.
Check	1.498
K 100	1.658
P 300	1.658
P 300, K 100	1.697
N 100, P 300, K 100	1.673

Table beets also respond to fertilization as indicated by the changes in the concentration of the cell sap. When grown on Chandlers muck soil the results obtained were as summarized in Table 4.

Table 4.—The effect of fertilizer on the concentration of cell sap of table beets. Chandler's marsh.

Treatment	Freezing point lowerings °C.
No treatment	0.874
K 500	0.984
P 250, K 500	0.989
P 750, K 500	1.002
P 750	0.944
N 300, P 750, K 500	1.124
M—20 loads	0.951

It is to be noted that the concentration is affected by all treatments of this soil and that the density of the sap in the table beets is less than that in the sugar beets grown under similar conditions.

The juice of the table carrot is affected to a slight extent by fertilization when grown on the Chandler muck soil. The relationships are brought out by the data given in Table 5.

Table 5.—The effect of fertilizer on the concentration of cell sap of table carrots. Muck soil.

Treatment	Freezing point lowerings °C.
K 500	0.925
Check	0.898
P 750, K 500	0.903
N 300, P 750, K 500	0.938

The concentration of the juice of the onion is affected somewhat by the fertilization of muck soil that is deficient in mineral elements of plant food. Where this crop was grown on muck near Byron Center, Michigan, the freezing point lowerings of the ground material are as given in Table 6.

Table 6.—The effect of fertilizer on the concentration of cell sap of onions. Muck soil.

Treatment	Freezing point lowerings °C.
K 400	0.818
K 400, P 500	0.872
N 300, P 500, K 400	0.951
Check	0.708
P 500, K 250	0.819
P 500	0.827

Studies have been made on the effect of fertilization upon the concentration of the juices of ground leaves of several crops, but only the results ob-

tained from sugar beets and carrots grown on muck soils are given at this time.

Table 7.—The effect of fertilizers on the concentration of the sap of sugar beets and carrots. Muck soil.

Treatment	Table beets freezing point lowerings	Carrots freezing point lowerings °C.
None	.630	1.118
K 500	.778	....
P 500, K 500	.764	....
P 750, K 500	.759	1.208
P 750, K 750	.837	1.258
P 750, K 375	.813	1.238
P 750	.595	1.190
M, P 750, K 750	.759	1.172

These results bring out that the addition of potash to this muck soil increases the concentration of the juice of the leaves of these crops. Whereas, phosphorus has a tendency to reduce the sap concentration of the table beets.

In view of the response of the cell sap of several crops as measured by the density or concentration, it seemed advisable to study the mineral content of the juice expressed from crops grown on differently treated soils, because it was considered that there might be a relationship between the composition of the sap of plants and the soil upon soils upon which they grow. We have accumulated a large amount of data on the relative amounts of phosphorus and potassium present in the juices expressed from crops grown on differently fertilized soils. Some of this information we have obtained with phosphorus is given in Table 8.

Table 8.—Amounts of phosphorus in the sap of celery and of cabbage on differently fertilized muck soils.

Treatment*	Celery P	Cabbage P
K 500	1	1
P 500, K 500	....	2
P 750, K 500	4	....
P 750, K 750	3	3
P 750	4	3
Check	3	2
N. P. K	4	3

*Figures show relative amounts in each plant.

It appears from our studies that the phosphorus content of the cell sap of plants is affected by soils and their fertilization. It further appears that the amount of inorganic phosphorus varies with the time of day; the amount being greater in the morning than later on in the day, and in some instances, more inorganic phosphorus is found in the stems than in the leaves. It may be that a phosphorus deficiency in the soil may be detected by cell sap studies by crops grown on it.

The juice of several crops grown on muck soil fertilized with potash has been found to contain considerable more potassium than that from those grown on similar unfertilized soil.

TEST SOILS FOR WATER-SOLUBLE PHOSPHORUS

Simple Field Check Gives Information on Fertilization Needs—Past Use Proves Practicability of Method

C. H. SPURWAY, SOILS SECTION

In the author's laboratory studies on the solubility of phosphorus fertilizers when applied to treated and untreated soils, certain results were obtained which led to conclusions concerning the soil factors operating to cause phosphorus to become insoluble or fixed in the soil, or to remain in a more or less soluble condition. In order to test the practicability of these conclusions, it became necessary to devise a sensitive, easily applied field method for determniing soluble phosphorus in the soil, and the method herein described is the result of the author's endeavors along this line.

This test is based on the facts already established that the chemical reaction between phosphorus in the form of orthophosphate and a solution of ammonium molybdate in the presence of nitric acid is extremely sensitive; and that the chemical reduction of the molybdenum in the ammonium phosphomolybdate compound thus formed gives a blue color. The author found by experimentation that the effects of silica on this reaction were eliminated by using a certain proportion of ammonium molybdate to nitric acid and water in preparing the ammonium molybdate reagent; and that the reducing process could be carried out successfully by stirring the acid solution of ammonium phosphomolybdate with a piece of tin metal.

The test is relatively accurate, and easily and rapidly applied in the field. No glassware is required for the tests, other than the reagent containers fitted with droppers; hence, the necessity of washing dishes in the field, and the danger of contaminating the tests, are entirely eliminated. In pure solutions of sodium phosphate, the test is sensitive to one-fourth part of phosphorus to one million parts of water. The test is also sensitive to arsenic in the form of arsenate, which may interfere with its use on soils where arsenical sprays have been used in the control of crop insects.

Materials Required for the Test

1. Waxed papers—A medium weight paraffined paper cut in strips about ¾ of an inch wide and 3½ inches long. One piece of this paper is used for each test.

2. Water—The author prefers to use tap water. A dilute acid solution containing four cubic centimeters of concentrated nitric acid to one liter

of distilled water has been used for extracting soils in order to compare with the results obtained from water extracts. Both the water and the acid solution must be free from phosphorus. To test these solutions, place two drops of the solution on a piece of the waxed paper, add two drops of the molybdate reagent, mix by slight shaking, and stir with the tin pencil. A blue color should not appear.

3. Molybdate reagent—This reagent contains one part of ammonium molybdate, nine parts of distilled water and four parts of concentrated nitric acid. All of these substances must be free from phosphorus. The reagent is prepared in the following manner: Dissolve 25 grams of ammonium molybdate in 150 cubic centimeters of distilled water. If the solution is turbid, it should be filtered. Then pour this solution slowly into a cool mixture of 75 cubic centimeters of distilled water and 100 cubic centimeters of concentrated nitric acid, stirring the acid solution constantly until the solutions are thoroughly mixed. A smaller quantity of the molybdate reagent may be prepared, but the same proportions of the required substances are to be used. As this reagent is decomposed by light, it must be prepared away from strong light and kept in light proof bottles. Test this reagent at regular intervals of time in the same manner as previously described for testing the water, using distilled water or water known to be free from phosphorus.

4. Tin pencil—The author uses a rod of tin 3/16 inch in diameter and four inches long pointed on one end like a lead pencil. This tin pencil was made by pouring molten tin into a piece of glass tubing and then after cooling, breaking the glass away from the metal. The point of this tin pencil should be wiped on a piece of cloth after each test, and also scraped occasionally with a knife blade, or spatula, in order to keep it bright.

In the testing operation, a water, or dilute acid, extract is first obtained from a soil sample. The molybdate reagent cannot be diluted more than one part of soil extract to one part of the reagent. Therefore, in order to determine how much of the soil extract to use in making the test, place two drops of the molybdate reagent on a piece of the waxed paper, then in performing the test, draw an amount of clear extract away from the soil equal in size to the two drops of reagent, and then add to this amount of soil extract two drops of the molybdate reagent before developing the blue color by stirring with the tin pencil.

Method of Performing the Test

Fold a piece of the waxed paper once lengthwise. Hold the folded paper between the thumb and forefinger of the left hand and open the paper to form a trough. With a knife blade, or a small spatula, place some of the soil to be tested in the end of the paper trough close to the hand and then push the soil slightly away from the hand with the point of a knife blade, or the tin pencil, in order to make a cavity behind the soil sample to receive the water or other solution used for extracting the soil. The soil sample should fill the paper trough to the top edges and extend about one inch lengthwise on the paper, and it should be mellow and friable and placed on the paper in a loose condition. During the testing operation, care must be taken not to mix or puddle the soil in any way with the extracting solution.

Drop the extracting solution into the paper trough back of the soil sample, slowly and carefully, allowing the soil to take up the solution drop

by drop, and controlling the movement of the solution through the soil by tipping the open end of the paper slightly downward. The solution must move slowly through the soil, not over or around it, otherwise clear extracts may not be obtained. When the clear soil extract appears at the outer or lower end of the soil sample, it is separated from the soil mass by touching the edge of the soil extract with the tip of the tin pencil and drawing a portion away to the outer end of the paper. Several of these drawing out operations may be necessary in order to obtain a sufficient amount of the clear extract for making the test. When two drops of the soil extract has been obtained and isolated at the outer end of the paper, add to it two drops of the molybdate reagent, shake the paper slightly to mix the extract and reagent and stir with the tip of the tin pencil for about ten seconds. If phosphorus is present in the soil extract, a blue color developes and the intensity of this blue color is a measure of the quantity of phosphorus present up to the maximum color obtainable from this reaction.

The maximum intensity of this blue color develops in a short time, and then the color gradually fades out. If a comparison of two or several soil samples is desired, the extracts may all be obtained at first, and the molybdate reagent added and the blue color developed in all the extracts at nearly the same time. In making comparative tests, approximately the same quantity of each soil sample should be taken. A slight turbidity of the soil extract does not seriously affect the test; but the strongly acid molybdate reagent must not come in contact with the soil sample or small detached particles of the soil. The described technic works well on all soils except plastic clays, and sometimes great care is necessary in order to obtain clear extracts from highly deflocculated muck soils.

Notes on the Practical Application of the Test

During the past crop season many hundreds of tests have been made with this phosphorus test on field soils, more particularly with the idea of developing a suitable technic for it, and of determining its application and limitations. Tests have been made on several soil types and on fertilized and unfertilized fertility test plots both on mineral and organic soils. Although these studies are still in progress, the results obtained to date indicate that the test can be used successfully in several lines of research pertaining to soil phosphorus, and that useful information can be obtained with it relative to the application of phosphorus fertilizers to cultivated soils.

A complete discussion of the results obtained by means of this test must be left for future papers on the subject. It is intended to present here only a brief summary of conclusions which seem to be justified by present knowledge and experience. These conclusions, except when otherwise stated, refer to water soluble phosphorus, and are based on test results together with a knowledge of the crop producing power of the soils tested.

1. It appears that in order for a soil to contain the optimum quantity of either natural or applied phosphorus, it must deliver to plants growing on it a certain, although small, quantity of soluble phosphorus continuously throughout the growing season. However, this quantity of phosphorus may, and probably does, vary somewhat for the different classes of soils and crops, depending chiefly on the supply of other plant nutrients. An attempt was made to determine this optimum point, but present data are insufficient although promising; however, in cases where we had reason to

think that soils contained a sufficient supply of phosphorus, marked tests for water soluble phosphorus were obtained.

2. Several cases were found where soils that originally gave decisive tests for soluble phosphorus responded very little if at all to applications of phosphorus fertilizers. Conversely, soils that gave very low or negative tests, responded well to applied phosphorus.

3. On some soils, differences in content of soluble phosphorus between check plots and phosphorus treated plots on fertility experiments could be shown easily when the check plot tests were low and when the tests were made shortly after the phosphorus fertilizer had been applied. The content of soluble phosphorus seemed to become less on some soils as the season advanced, while on other soils this phenomenon was not observed.

4. No correlation between test results and quantity of applied phosphorus was exposed. Some soils required large amounts of phosphorus fertilizer before phosphorus showed in the water extract; while other soils responded to the test after the application of relatively smaller amounts of fertilizer. In this connection it may be possible to use the test to advise a phosphorus requirement method for soils.

5. Some soils gave a low water soluble test but a high acid soluble test, showing that phosphorus was present, but not in a water soluble form.

6. Differences were observed between broadcast and row applications and different amounts of applied phosphorus. Indications that applications of muriate of potash and common salt tend to keep applied phosphorus more soluble, that acid phosphate is more soluble than basic slag, and that lime tends to decrease the solubility of acid phosphate in the soil were observed; but not on all the soils tested. The reason for failure to get consistent results in this respect on all the soils probably lies in the matters discussed under division number 4 of this summary.

7. Data were obtained which show that phosphorus moves in soils dissolved in the soil solution. Soluble soil phosphorus moves to the surface of soils during drying weather and is deposited there as the soil water is being evaporated; and some of this phosphorus is washed into the soil again by rains.

PROFILES OF MICHIGAN SOILS

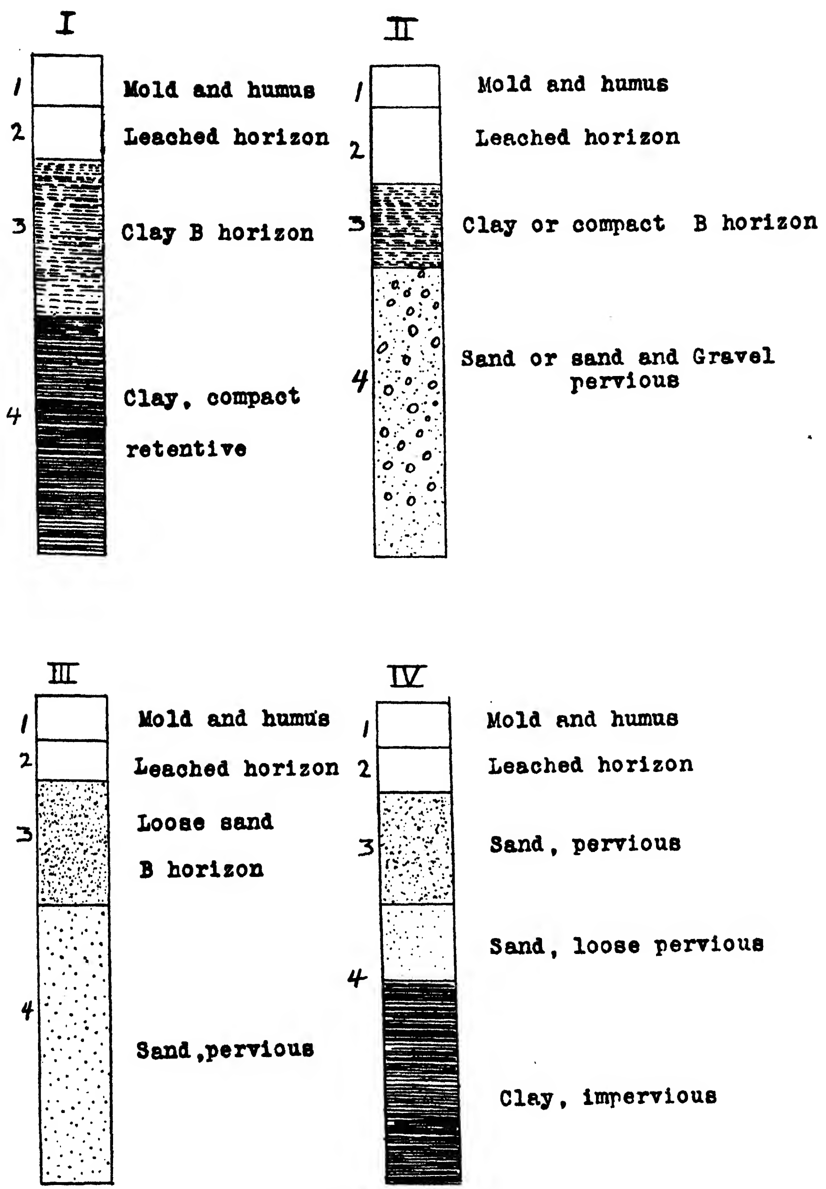
Soil Groupings Made More Practical By Detailed Study—Virgin Soil Less Acid Than Cultivated

BY J. O. VEATCH, SOILS SECTION

The studies of soils which are being made in connection with the detailed soil surveys of the counties of Michigan, are enabling us to make broad groupings of the soils of this state and generalizations about their chemical and physical nature with more assurance and safety than heretofore. It is probable that all of the mineral soils of this state, existing or developed under conditions of good drainage, are, with very few exceptions, comprised in the four broad textural and structural profiles here illustrated.

In our recent profile studies, it has been found in general: (1) that the surface layer of the virgin soil, in which there has been an accumulation of humus is higher in elements of fertility and less strongly acid, particularly in the heavier soils than the horizon of mineral soil directly beneath it; (2) that there is a horizon of variable thickness, which lies just beneath the mold or humus soil, which represents maximum leaching and removal of the more soluble constituents, while at a shallow depth the soil reaches a point of maximum acidity; (3) that lime or calcium carbonate has been leached or removed generally to depths of two to five or six feet; that the removal has taken place to greater depths in the sands than in the clays; that the substrata are universally calcareous or alkaline in reaction, most markedly so in clay and gravel, less so in sand; (4) that there is a horizon (soil layer) at variable depths, but above the substratum, in which there is a maximum amount of clay and colloids, due either to weathering in place or to concentration or to both.

The profile analysis has an interest and significance not only to the scientist in soil classification, but also to the farmer who cultivates the staple general farm crops, the horticulturist, the forester, the drainage engineer and the highway engineer. Certain soil types belonging in I and II profiles for example, may exhibit an acid plow soil, yet support a good growth of legumes when the roots have penetrated to the limey or alkaline soil which lies at shallow depths, while on certain types belonging to No. IV profile the plants may fail both because of greater depth to lime and greater acidity. Trees may send roots down to the clay substratum in the IV profile and exhibit a good growth on what is apparently an infertile sand, while on a type belonging in profile III the growth of the same species may be poor and the tree shorter lived. On certain soil types of this state, roots of trees have been observed to extend to depths of as much as 15 feet, while on certain other soil types comprised in profile I, the roots of trees may flatten out at depths of only 2 or 3 feet. The roots of grasses, clover and



Group profiles of Michigan Soils

alfalfa have been observed to penetrate to depths of 2 to 4 feet or more. The average content of moisture or water is relatively high throughout the year in soil types comprised in profile I, while it is relatively low in profiles II and III and the movement of water freer. Soil types of sand texture in IV may appear dry at the surface, yet contain abundant moisture at shallow depths on account of the clayey and impervious nature of the deep substratum.

A knowledge of the virgin profile enables us to understand better the changes which have taken place in the plow soil due to cultivation. In many instances, due to erosion, horizon 3 of profiles I and II comprises the greater part of the plow soil which must differ markedly in plant response and tilth from the original top soil. Probably in most soils, the present plow soil represents a mixture of two or even three separate members or horizons of the virgin soil. Even in a forest or cut-over land the overturning of large trees may bring to the surface horizons of mineral soil quite unlike the virgin mold and humus in effect upon the plant, so that the growth of a seedling may be different in one spot as compared with another only a few feet away.

The foregoing examples and illustrations are merely suggestive, but indicate the importance of the study of the soil profile including the deep substrata.

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·hatham, Alger County, 780 acres deeded. G. W. Putnam, Director.
·outh Haven, Van Buren County, 10 acres rented; 5 acres deeded. S. Johnston, Supt.
Graham Station, Kent Co., 50 acres donated by R. D. Graham; 50 acres purchased. H. M. Wells, Supt.
Dunbar, Chippewa County, Forestry station, 577 acres deeded.
Monroe, Monroe County, Corn Borer Station, 7½ acres rented.

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R. S. SHAW AND E. B. HILL

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MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN

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VARIETIES OF GENERAL CROPS FOR MUCK LAND

A Comparative Study of a Few Varieties Which Have Been Grown Successfully on Muck

BY PAUL M. HARMER, SOILS SECTION AND C. E. CORMANY AND E. E. DOWN, FARM CROPS SECTION

The production of satisfactory yields of the various general crops in Michigan is to a considerable extent dependent on the type of soil upon which they are being produced. The variation in soil in the state is great; from heavy clay to coarse sand on the one hand and to muck on the other. In a consideration of the mineral soils, the problem has been largely solved by a selection of those general crops which are especially suited to the type of soil, as, for example, wheat and sugar beets on the heavy soils and rye and potatoes on the sandy loams. At the same time, there has been great improvement in the varieties for those soils. In the case of the muck lands, however, the proportion of the general crop failures has been relatively large, irrespective of the kind of crop being grown. Generally, these failures have been due to a lack of proper fertilization of the muck land for the crop being grown, but in many cases they have been due to the growing of varieties which are not at all adapted to muck land.

The two most important factors in determining what variety of a crop is suitable for a given locality are the climate and the soil of that locality. By climate we refer to the temperature and atmospheric conditions of the locality. In these respects, our muck lands are markedly different from our mineral soils. In the spring, the muck land is generally slower to warm up than is the mineral soil so that planting is delayed. In the fall, killing frosts usually occur considerably earlier on the muck than on the mineral soil. The net result is a shorter growing season. From the standpoint of the climate of the soil, we might, therefore, consider that our muck lands are geographically out of place and should be grouped with the mineral soils located several hundred miles to the north, insofar as general crop varieties are concerned.

Composition of Muck Soil

Muck soil is also very different from mineral soil in its composition. Practically all mucks are very low in content of potash and quite low in phosphoric acid, as compared with mineral soils. On the other hand, muck contains several times as much nitrogen as does mineral soil.

This large excess of nitrogen is reflected in an excess growth and lodging of the above-ground growth, especially of small grains, and also in a delaying of the maturity of the crop. While the application of phosphate fertilizer in studies made by the senior author, has counteracted to a large extent the delaying of maturity caused by the excess nitrogen, the use of potash has not entirely prevented the lodging of small grains.

Because of this marked difference in soil climate and soil composition, the improved varieties of many general crops, which have been very successfully grown on the mineral soils of the state, have not in all cases proven desirable for the muck soils. Instead it is necessary to look to those varieties of grain and corn which are adapted to more northern latitudes, varieties which will mature earlier and which are shorter and consequently less likely to lodge. Such varieties of grain which have been selected for stiffness of straw, are especially desirable for our muck land. In this connection, mention should be made of the fact that the Minnesota station has found Rosen rye, a Michigan variety, to be best adapted for the muck lands of that state.

Experimental results. The studies reported herein were conducted in conjunction with fertilization studies made by the soils department and were made co-operatively by the soils and farm crops departments. Under the conditions, no attempt was made to undertake an exhaustive comparison of varieties on muck. Instead, only a few varieties, most of which had given considerable promise on muck land, were compared. The results given are the averages of from three to twelve plots in each case.

Oats. Five varieties of oats were compared to some extent on several different muck areas, the results from five of which are given in Table 1. Of the oat varieties, the Iowar, and Iowa 103 were developed by the Iowa Experiment Station and the Gopher 674 by the Minnesota Station. These three had been selected for early maturity and stiffness of straw. The Wisconsin 7, developed by the Wisconsin Station, was recommended as a variety which filled, even though it had lodged. The Worthy was one of the earliest and is the shortest strawed of the Michigan varieties. Of the muck areas on which the trials were made, the Allegan County muck was very shallow while the other four were deep mucks. All five were either sweet or only slightly acid and not in need of lime.

Of the five varieties, the Wisconsin 7 and the Worthy showed the greatest tendency to lodge. The Iowa 103 matured earliest, but the oats had a tendency to shell out as soon as ripened. Both the Gopher and the Iowar stood up well, producing good yields, except on the Oceana county muck in 1924 and 1925, on both of which years the crops was injured by a summer frost.

Barley. Five varieties of barley were compared on several muck areas, the results from three of which are presented in Table 2. Of the five, Minsturdi 184 and Manchuria 439 are two varieties developed several years ago by the Minnesota Station, both of which have shown promise on the peat lands of that state. The Peatland is a new variety developed by the same Station, especially for their peat soils. The Wisconsin Pedigree is a standard variety developed by the Wisconsin Station, while the Michigan Black Barbless is one developed by

Table 1.—Comparison of oat varieties on muck.

Fertilizer treatment	Iowar		Iowa 103		Worthy		Gopher 674		Wisconsin 7	
	Grain bu. per acre	Straw tons per acre	Grain bu. per acre	Straw tons per acre	Grain bu. per acre	Straw tons per acre	Grain bu. per acre	Straw tons per acre	Grain bu. per acre	Straw tons per acre
ALLEGAN COUNTY										
(1923) Unfertilized	39.5	0.76	31.2	0.57	....	....	....	....	....	....
(1923) Well fertilized	42.9	0.99	40.7	0.74	....	....	....	....	....	....
INGHAM COUNTY										
(1923) Well fertilized	52.0	1.8	41.6	1.6	36.0	2.5	....	....	....	....
(1924) Well fertilized	36.2	1.2	32.5	1.3	....	....	....	....	31.8	1.3
JACKSON COUNTY										
(1925) Unfertilized	14.2	0.7	....	....	....	....	12.4	0.5	....	....
(1925) Well fertilized	47.2	1.4	....	....	....	....	54.5	1.6	....	....
OCEANA COUNTY										
(1923) Well fertilized	45	....	....	....	32.0	....	....	....	....	....
(1924) Well fertilized	26	....	22	....	....	....	20	....	15	....
(1925) Well fertilized	15.3	0.6	....	....	....	....	24.8	0.6	....	....
GRATIOT COUNTY										
(1924) Well fertilized	47.3	1.8	44.6	1.7	....	....	51.3	1.8	....	....

Table 2.—Comparison of barley varieties on muck.

Fertilizer treatment	Grain bu. per acre	Straw tons per acre	Grain bu. per acre	Straw tons per acre	Grain bu. per acre	Straw tons per acre	Grain bu. per acre	Straw tons per acre
	Wisconsin Pedigree		Minsturdi 184		Michigan Black Barbless		Manchuria 439	
OCEANA COUNTY								
(1923) Well fertilized	38	....	22	....	28	....	....	....
(1925) Well fertilized	....	....	27.3	....	....	....	34.8	....
JACKSON COUNTY								
(1925) Well fertilized	....	....	44.2	1.3	....	....	39.4	1.1
INGHAM COUNTY								
	Wisconsin Pedigree		Peatland					
(1926) Unfertilized	5.7	....	8.8	....	....	....	....	....
(1926) Well fertilized	17.8	....	30.8	....	....	....	....	....

the Michigan Station which has shown some promise on our muck lands.

The Wisconsin Pedigree was the best of three varieties compared on the Oceana County muck in 1923 and 1924 and up to 1926 was the outstanding variety wherever we tried it out on muck land. In 1926, however, the Wisconsin Pedigree and Peatland were compared in three localities, in all three of which the Peatland proved much the better. This comparison of the two varieties will be continued in 1927.

Corn. The yields of eight different varieties of corn, compared to some extent on several muck areas, are given in Table 3. Of these, Wisconsin 25 and Garrod, both yellow dents, and Rustler White, a white dent, have produced good yields of mature corn. In solidness of ear, the Wisconsin 25 has been outstanding. The Duncan and Pickett, both Michigan varieties, were grown only on a new muck in Eaton county. The Mentha Muck corn, developed at Mentha, failed to equal the other varieties in either corn or stover.

Potatoes. Seven potato varieties were compared on muck land, the results from four of which are given in Table 4. Of these Russet Rurals, Russet Burbanks, White Rurals, and Green Mountains should be grouped as late potatoes, Early Ohio and Bliss Triumphs, as early, and Irish Cobblers as second early.

In a majority of the trials the Russet Rurals, White Rurals, and Irish Cobblers have produced good yields, with the Russet Rurals generally leading. Green Mountains failed to equal the yields given by most of the other varieties on the Ingham County muck in 1923, but

Table 3.—Comparison of corn varieties on muck.

Fertilizer treatment	Corn bu. per acre	Stover tons per acre	Corn bu. per acre	Stover tons per acre	Corn bu. per acre	Stover tons per acre	Corn bu. per acre	Stover tons per acre
	Wisconsin 25		Horse tooth dent		Mentha muck		Garrod	
LAPEER COUNTY—1921								
Unfertilized	9.7	0.7	4.8	0.7	0.6	0.7	8.2	0.7
Well fertilized	69.6	2.4	55.9	2.0	33.9	3.1	73.1	3.1
BERRIEN COUNTY—1921								
	Wisconsin 25		Local White Dent					
Unfertilized	14.9	1.9	12.6	0.7	3.3	0.2	....	....
Well fertilized	59.3	1.9	73.0	1.6	29.0	0.9	....	....
JACKSON COUNTY—1925				**EATON COUNTY—1921**				
	Wisconsin 25		Rustler White		Duncan		Pickett	
Unfertilized	10.9	....	13.2	....	53.2	1.8	44.4	1.0
Well fertilized	49.8	....	68.7	....	59.8	2.2	57.2	1.6

Table 4.—Comparison of potato varieties on muck.

Fertilizer treatment	Bu. per acre	Percent marketable	Bu. per acre	Percent marketable	Bu. per acre	Percent marketable	Bu. per acre	Percent marketable	Bu. per acre	Percent marketable	Bu. per acre	Percent marketable
	Russet Rurals		Russet Burbanks				Russet Rurals		White Rurals		Irish Cobblers	
EATON COUNTY												
	1922						1925					
Unfertilized	60	65.3	55	66.2	...	...	166	94.5	151	95.4	128	87.9
Well fertilized	241	96.2	117	88.8	...	...	364	98.2	341	98.1	287	90.7
ALLEGAN COUNTY												
	1922						1924					
Unfertilized	62	81.3	25	50.1	...	...	112	81.7	85	70.8	...	...
Well fertilized	77	88.0	34	65.8	...	...	213	96.7	129	92.2	...	...
JACKSON COUNTY—1925												
Unfertilized	...	...	...	...	...	...	72	74.8	74	69.1	85	57.5
Well fertilized	...	...	...	...	...	...	261	96.1	254	96.8	260	93.2
INGHAM COUNTY												
	Russet Rurals		Irish Cobblers		Green Mountains		White Rurals		Russet Burbanks		Early Ohio	
(1923) Unfertilized	68	85.9	61	72.6	48	78.3	65	88.2	50	62.4	56	76.9
(1923) Well fertilized	108	96.0	113	88.5	74	91.4	109	96.2	72	73.2	116	90.7
(1925) Unfertilized	76	85.7	75	69.6	...	...	78	94.2	...	...	...	...
(1925) Well fertilized	187	98.1	156	86.4	...	...	177	98.4	...	...	...	...
	Russet Rurals		Irish Cobblers		Green Mountains		Bliss Triumphs					
(1926) Unfertilized	97	92.5	57	81.9	86	93.3	55	81.1	...	...	...	...
(1926) Well fertilized	140	95.1	112	90.7	152	97.5	116	96.0	...	...	...	...

gave the highest yield in 1926. The reduced yields on the Allegan muck in 1922 were due to drought while those on the Ingham county muck were decreased by early frost in 1923 and by excessive rains in 1926.

Sugar Beets. It is a well known fact that sugar beets grown on muck land, do not have the sugar content of those produced on mineral soil. To a considerable extent, this low sugar content is due to lack of potash and can be increased by the use of commercial fertilizer high in potash.* To some extent, it seems also due to immaturity. This assumption has confirmation in the fact that the sugar

Table 5.—Comparison of several selections of sugar beets on muck.

Fertilizer treatment	Selection number of beet.							
	1924				1926			
	A	B	C	D	E	F	G	H
BEETS—TONS PER ACRE								
Unfertilized	3.3	3.1	2.1	3.6	4.3	2.2	5.0	3.2
Well fertilized	10.5	9.6	8.8	10.4	10.7	6.2	9.1	8.5
Ave. all plots (1)	7.9	7.8	7.0	8.3	8.3	4.7	7.5	6.6
TOPS—TONS PER ACRE								
Unfertilized	2.0	1.7	1.4	2.0	....	....	....	....
Well fertilized	9.4	10.6	10.4	8.8	....	....	....	....
Ave. all plots	6.7	8.1	7.7	6.8	....	....	....	....
PERCENTAGE SUGAR (2)								
Unfertilized	14.1	10.4	12.1	10.6	11.3	11.4	9.4	9.7
Well fertilized	14.8	13.2	14.1	13.4	13.4	13.9	12.0	11.9
Ave. all plots	14.6	12.3	13.4	12.5	12.6	12.9	11.1	11.2
SUGAR—LBS. PER ACRE								
Unfertilized	931	645	508	763	972	502	940	621
Well fertilized	3108	2534	2482	2787	2868	1724	2184	2023
Ave. all plots	2307	1919	1876	2075	2092	1213	1665	1478
PERCENTAGE PURITY								
Unfertilized	80.8	81.2	83.1	75.7	83.8	81.2	79.2	77.0
Well fertilized	86.1	82.6	84.1	83.8	86.1	88.3	83.6	82.2
Ave. all plots	83.3	82.1	83.8	81.1	85.7	85.5	82.3	81.6

(1) Average number of plots—1924—Beets and tops—12 plots. Percentage sugar and percentage purity—4 plots. 1926—Beets, sugar and purity-average of 9 plots.

(2) Sugar determinations made by: (1924) Lansing Sugar Co.; (1926) Prof. O. B. Winter of the Chemistry Experiment Station, M. S. C.

*The Muck Soils of Michigan—Their Management for the Production of General Crops, Michigan Spl. Bul. 136. Page 57.

content varies markedly with the date of planting on muck, the early planted beets being much the best in this respect.

In a comparison of several selections of sugar beets, strains were chosen by Mr. Down from a large number which he is developing in his sugar beet investigations on mineral soil. The yields per acre of roots and tops, the sugar content, yield of sugar per acre and purity of the beets grown on the Ingham County muck are shown in Table 5. The uniformly low sugar content of these beets was probably largely due to late planting.

The results indicate that it may be possible by selection and breeding to develop a satisfactory sugar beet for muck soil. A selection which will give a good tonnage and at the same time have a high sugar content and a high percentage purity is to be desired. Of the eight selections tried out numbers A and E are most promising.

POWER POSSIBILITIES OF SMALL STREAMS

Some Suggestions for Making a Preliminary Survey

O. E. ROBEY, AGRICULTURAL ENGINEERING SECTION

There are a great many small streams in Michigan which could be "harnessed" and used to supply electric energy to the farms through which they pass. On the other hand, there are a good many other streams which it would be impractical to develop for power purposes. The purpose of this article is to give a few simple rules for making a preliminary survey to determine the practicability of developing power from a stream.

In making this survey the following factors should be considered:

1. Distance of stream from house.
2. Riparian rights of neighbors.
3. Ease of building dam.
4. Uniform flow.
5. Fall available.
6. Volume of water flowing.

The distance of the stream from the house, at least the point where the dam is to be located may greatly affect the cost. The greater the distance this point is from the house, the more the transmission line will cost and also it may be necessary to use a higher voltage. If a storage battery is used, it will be more expensive. Thirty-two volt, one hundred ten volt, or even higher voltage current can be used depending on the distance of the dam from the buildings and the amount of power available.

The riparian rights of parties having property abutting the stream above the dam must be secured either by gift or purchase. That is,

if in constructing the dam the water floods over neighbor's property or even raises the level of the stream in front of his property, a neighbor may have a rightful claim for damages.

The cost of the installation may be influenced by the kind of dam required, materials available and other factors. If the stream flows through a wide valley, a long dam will be necessary. A quick sand bottom in the stream may make it difficult to build a dam.

If about the same amount of water flows through the stream at the various seasons of the year, it will be more valuable as a power stream. A stream that dries up in the summer or floods at other seasons is not a good power stream. Too much water reduces the amount of power produced as much as a scarcity of water and very often endangers the dam.

The fall available directly influences the amount of power which will be secured. This can be determined by having a surveyor take levels along the edge of the stream. If the distance is short, this can be done roughly with a carpenter's level. Usually, unless a dam three feet high can be built, very little power can be secured from a small stream.

A rough estimate of the volume of water flowing can be made by a few simple measurements. The volume is the product of the width by the depth by the rate of flow. In measuring the depth of the stream, allowance should be made for the curvature of the bottom. An average depth should be taken. In measuring the width, the still water along the edges should not be included. To determine the rate of flow, a stake should be driven on the bank of the stream about 100 feet above the point where the dam is to be built. By throwing a light piece of wood in the stream opposite the stake and measuring the distance it will travel in one minute an approximate rate of flow can be secured. The average of several trials will give a more accurate figure.

After these measurements have been made, their values can be inserted in the following formula and by a simple process of multiplication and division, the approximate horse power of the stream can be determined:: The formula is

Depth in inches x Width in ft. x rate of flow in ft. per min. x Fall in Ft. ÷ 12,690 = Horse Power

This formula takes into consideration estimated losses in the water power machinery and should give the horse power available for producing power or electricity. One horse power will supply the current for 15-fifty watt electric light bulbs, or will supply the current for one flat iron and 2-forty watt bulbs.

A survey made according to the suggestions given above can only be expected to give approximate results, and should only serve as a guide for further action. If the survey indicates that the stream has power possibilities, the matter of development should be taken up with some company specializing in this class of machinery. They generally will be glad to furnish plans for the installation and usually their experience will be very valuable in preventing mistakes in design.

GROW BETTER POTATOES

Certified Seed Will Improve the Quality of Potatoes and Give Increased Profits

H. C. MOORE, FARM CROPS SECTION

The need for growing potatoes of good market quality is urgent. Growers cannot realize satisfactory profits from the potato crop if they put potatoes of inferior quality on the market. The market demands potatoes that are of medium size, smooth, well shaped, and practically free from disease. The planting of poor seed is one factor that is largely responsible for the production of rough, ill-shaped, and diseased potatoes.

Numerous tests in Michigan have shown that certified seed not only gives increased yields, but that it also improves the quality of the stock grown. An increase of 46 bushels per acre and a 20 per cent improvement in quality are the average results secured in the tests.

Certified seed is superior to non-certified seed because it is practically free from such diseases as leaf-roll, mosaic, fusarium wilt, and others that often produce misshapen tubers. Furthermore, certified seed is produced by the hill selecting method from stock that has been selected for high yield, good type, and freedom from disease. Diseased and off type plants are removed from certified fields. High standards of certification and a thorough inspection system are maintained by the Michigan State College to insure the production of high yielding disease free seed.

Varieties

The varieties of certified seed available to Michigan growers are Russet Rural, White Rural, Green Mountain, and Irish Cobbler. They can be procured from the Michigan Potato Growers Exchange, Cadillac, Michigan or through the Farm Crops Department of the Michigan State College.

The Russet Rural (Late Petoskey) is the leading late variety in Michigan. It is a vigorous and satisfactory yielding variety. Its skin is well russetted and quite tough, so it withstands minor bruises better than varieties that have a thin, smooth skin. It is particularly adapted to the sandy loam types of soil.

The White Rural is an excellent late variety that is quite similar to the Russet Rural in habit of growth. The skin is white and smooth. On heavy types of soil it is preferred to the Russet Rural which is often dark in color when grown on clay or clay loam soils.

The Green Mountain is a variety of high quality that matures approximately two weeks before the Russet Rural or White Rural. It is not as resistant to droughts, hot weather, and leaf hopper injuries

as the Rural varieties and for this reason it is grown most extensively in the Upper Peninsula where it is favored by a cool moist climate.

The Irish Cobbler is the best early variety for most sections of Michigan. When it is planted on a fertile soil and is well sprayed with bordeaux mixture throughout the season, it produces very good yields. Many growers who are located near good markets have found this a very profitable variety.

Community Potato Production

The most satisfactory results can be secured if the production of high quality potatoes is considered as a community project. Where a number of growers in any community combine their efforts to improve the quality of their potatoes, they can more readily command the highest prices for their crop. By concerted effort, they can market large quantities of good potatoes that will soon establish for their community a good reputation on the markets.

The co-operative buying of certified seed in car load lots by growers in a community is one of the first steps in the better potato project. A car will contain approximately 600 bushels of seed, which will plant approximately 35 acres. The car of seed could be planted by a number of growers in plots of one acre or more. The plots should be separated from other potato fields so as to lessen the risk of infecting the certified seed plots with disease.

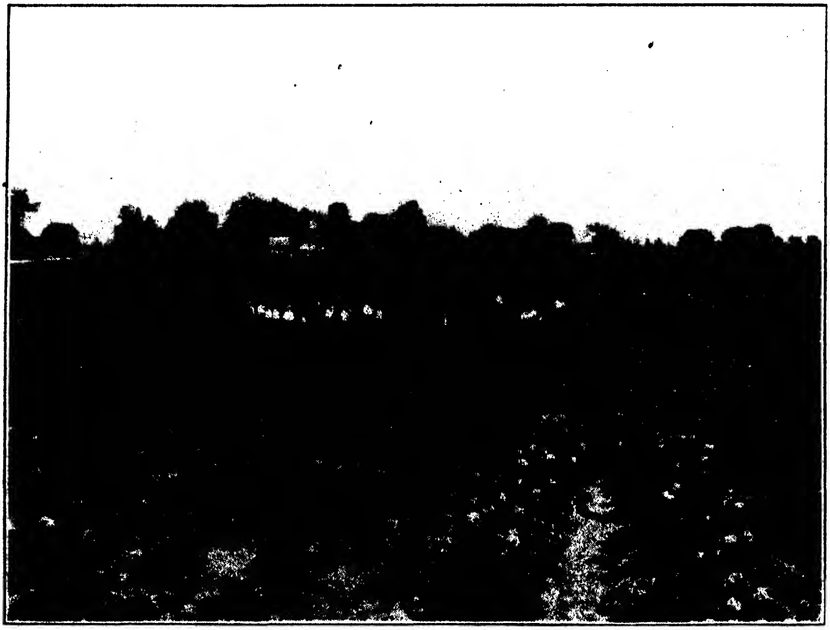

Figure I.—Inspecting a field of Certified Seed Potatoes in Montcalm County.

The plots should be rogued and thoroughly sprayed with bordeaux mixture and at harvest time care should be taken in selecting seed for the next year's plot. By this method, the grower of table stock could in one year's time produce sufficient high quality seed to plant his entire potato acreage.

Through the assistance of county agricultural agents and extension specialists of the Michigan State College demonstrations in fertilization, spraying, rogueing, seed selection, and grading could be conducted that would be of great value to the community in producing better potatoes and in making its potato industry a more profitable one.

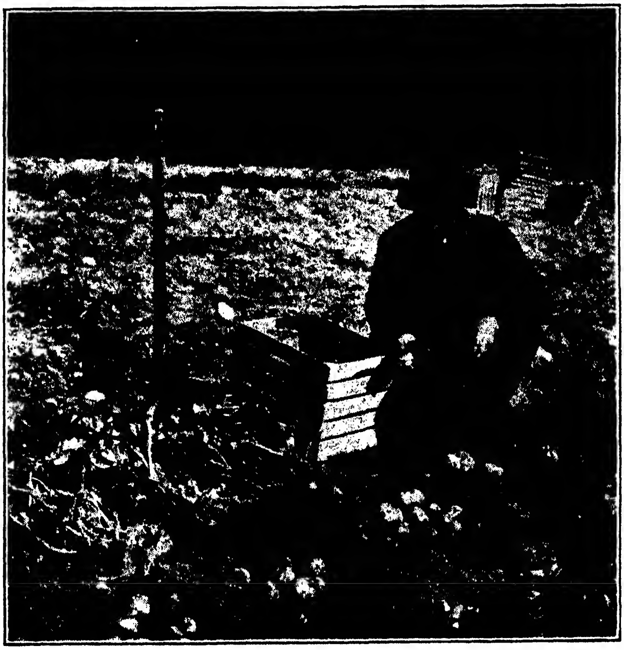

Figure II.—A Van Buren County grower of certified seed Hill Selecting from his seed plot.

PREPARING AND FERTILIZING POTATO SOILS

Climatic Conditions in Michigan Favorable for Development of High Quality Potatoes

FRANK W. TRULL, SOILS SECTION

This is an age in which low cost of production of high quality products on the farm is essential for maximum profits. The most successful potato growers in Michigan are those who year after year obtain large yields of high-quality potatoes. It is more profitable to grow 1,000 bushels of potatoes on four acres than it is to get the same yield from eight acres. The average in Michigan today is 1,000 bushels from eleven acres.

Conditions Affecting Yields

The conditions that govern the yields of this crop are:

Climate,
Soil type,
Crop rotation,
Good seed,
Plowing and fitting the land,
Fertilization, and
Spraying and rogueing.

Michigan's climate is well adapted to the production of potatoes. The potato grower should bear in mind, when considering potato production, that the potato is a cool-loving plant and cannot successfully be grown in warm climates. W. J. Smith of the United States Department of Agriculture states that the potato makes its greatest development in the sections of the country where the mean temperature in July is not over 70° F. The greatest yields of potatoes are in those States where the mean annual temperature is below 45° F. and where the mean of the warmest month is not far from 65° F. Michigan, with the exception of the southern part falls within this desired temperature.

Best Potato Soils

The potato is not as sensitive as some other plants in respect to soils, but it does succeed much better on some soils than on others. Generally speaking sandy loam soils, if well supplied with organic matter, are the most desirable types for potato culture. However, under suitable conditions a satisfactory crop may be grown on a fairly light sandy soil and on a medium heavy clay loam provided the heavy soil is well drained and the light soil has sufficient moisture. Muck

is also satisfactory if well drained and well supplied with available plant food.

Briefly stated, we might say that any soil other than blow-sand and heavy clay may be depended upon to produce a reasonably good crop, provided climatic conditions are right and plenty of organic matter and available plant food are present. Michigan has a large area of sandy loam soils that are situated within the limits of proper climatic conditions.

Place In Rotation

The potato crop should be so arranged in the crop rotation that it will follow a legume such as clover or alfalfa which adds a great deal of organic matter when plowed under. It is interesting to note that in Pennsylvania's 400 bushel potato club in 1926, 80 per cent of the members planted their potatoes on a legume sod. The decaying of the organic matter provides a supply of available plant food in the surface soil for the use of the potato plant. The decaying organic matter puts the plant food in available form, and it helps to conserve moisture. The organic matter tends to bind the sand particles together and thus increase the moisture-holding capacity.

The moisture content of the potato soil is very important. Careful, experimental studies have disclosed the fact that it requires 400 to 600 or more pounds of water to enable the potato plant to produce one pound of dry matter. Experiments have produced results which emphasize the importance of moisture to the potato crop during the period of its growth and particularly so during the development of the tubers, at which time the plant is subjected to its severest test. In the best potato-growing regions, the average rainfall between planting time and harvest ranges from 12 to nearly 18 inches.

Soil Preparation

In Michigan, the potato soil should be plowed to a depth of from six to eight inches. Fall plowing is preferred unless the soil is light and likely to blow. If not fall plowed, the plowing should be done early in the spring. The early plowing conserves more moisture and gives plenty of time for the decay of the organic matter before the potatoes are planted. After spring plowing, the soil should be firmed with the roller to prevent escape of moisture. The soil should be harrowed as soon as possible in the spring. A disk harrow is very efficient as it tends to cut the sod up into small pieces so that decaying is more rapid. The seed bed should be thoroughly worked to the depth of the furrow. Frequent shallow harrowing with a springtooth or spiketooth harrow should be continued until the potatoes are planted. The frequent use of the harrow kills the weeds that are sure to start and that task is accomplished much easier, quicker, and more economically with the harrow than it is with the cultivator after planting.

Use of Fertilizers

When a legume is plowed under for potatoes, a material reduction in the quantity of commercial fertilizer used, can be effected. When barnyard manure is used, it is more economical to supplement it with

commercial fertilizer than to place sole reliance on the manure alone. The manure is an unbalanced fertilizer, being high in nitrogen and low in phosphoric acid and potash. When supplementing manure with commercial fertilizer, one low in nitrogen and high in phosphoric acid and potash should be used. Barnyard manure should be applied to the land before plowing for potatoes. If it is applied just before planting there is a tendency to promote potato scab.

Results of tests carried on by the Soils Department show great benefits from the use of commercial fertilizers on potatoes. Complete fertilizers, that is fertilizers containing the three elements, nitrogen, phosphoric acid, and potash seem to give the greatest increase in yields. The average application per acre is increasing in Michigan. Best results are obtained where at least 400 pounds per acre are used, and many instances are known where 1,000 pounds per acre were the more economical.

Suggested Fertilizer Analyses

Following are a few fertilizer analyses that are suggested for typical potato soil under different systems of farming:

Legume used in the rotation	Legume and barnyard manure in rotation	Barnyard manure in rotation	No legume or barnyard manure in rotation
0-12-6	0-12-6	0-12-6	3-12-4
2-16-2	0-16-0	2-12-6	
		0-16-0	2-12-6

METHODS RECOMMENDED FOR INCREASING OAT AND BARLEY YIELDS

Proper Fertilization Methods Will Increase Yields and Give Better Quality of Grain

GORDON R. SCHLUBATIS, SOILS SECTION

The acre yields of oats and barley in Michigan are too low for maximum profit. The United States Department of Agriculture yearbook for 1925 gives the acreage of oats for this state as 1,642,000 and of barley as 126,000. Five year averages place the production of oats at 31 bushels per acre and barley at 24.2 bushels per acre. These are rather low yields, and, as compared with other States, Michigan ranks nineteenth, in acre production and eleventh in the number of acres grown.

In the case of barley, the situation is no better, for in yield Michigan ranks twenty-third and in total acreage twelfth. Economical increases

in the yields of these crops may be brought about by careful application of several practices which are:

The use of adapted varieties of seed*,
Limitation of production to adapted soil types,
Economical tillage practices, and
Proper fertilifiation.

Michigan Climate Favorable

Oats and barley are discussed together because they have about the same length of growing season, fit into the rotation the same, are sown about the same time, require the same seed bed preparation, and are adapted to the same soil types. Although oats and barley are grown over a large portion of the United States, Michigan is fortunate enough to be located in the humid region of slightly lower temperatures and more frequent summer rains, all of which is conducive to the most profitable spring grain production. Both oats and barley are sensitive to soil variation and even with our advantages as to climate many sections of the state experience low yields because of unfavorable soil types. These grain crops do not thrive on the light sandy loams but do well on soils of higher fertility and moisture holding capacity, such as our loams, silt loams and clay loams.

The common Michigan crop rotations have favored the practice of oats and barley following a cultivated crop such as corn, beans, beets, or potatoes. This has made possible various tillage operations in the preparation of the seed bed. These crops have been sown without any preparation of the seed bed and sometimes such methods have brought fairly satisfactory results. Since the physical condition of our soils has gradually become poorer, it is now necessary to pay more attention to seed bed preparation. Oats do not require a deep seed bed, but it should be well prepared. If there are many weeds or much crop residue on the field, it would be well to plow in the fall and then disk thoroughly in the spring. Where the preceding crop has been cultivated, it is a common practice to disk the soil from one to three times and give it a final harrowing sowing the oats with no further preparation of the seed bed. Experimental results indicate that there is but little if anything to be gained by plowing.

Fall Plowing Beneficial

It is essential that both the grains be sown at an early date in the spring, therefore, rapid but efficient methods of soil preparation should be used. Fall plowing, if plowing is to be done, puts this longer operation out of the way in the fall when time is not such an important factor. If the soil has been plowed in the spring, it will be too loose unless thoroughly firmed. The harrow and compacter, that is, a roller or cultipacker, should be used, and if the soil is well supplied with organic matter or it is a light soil, so it will not bake, it should be rolled after the seeding is done.

Michigan soils, especially the more sandy types, are apt to be acid, a condition which should be corrected by the use of limestone to

*Refer to Farm Crops Section Special Bul. 101.

realize the greatest yield per acre. Experimental results show increased yields of oats and barley through the use of ground limestone, marl, or other forms of lime. Legumes are often seeded with these crops or at least are grown in the rotation, and, for their successful growth, it is imperative that lime be applied.

In deciding upon the fertilizer to use for these crops, several things must be taken into consideration. The type of soil on which the crop is to be grown, the previous treatment of the soil and whether the following crop is to benefit by the residual effects of the fertilizer. On farms having a large supply of barnyard manure, the practice should be to apply this to the cultivated crop preceding the oats and barley. The quality of either oats or barley often suffers from too much nitrogen, a rank growth being produced which usually results in lodging and difficult harvesting. If these crops are to be grown on the light sandy loams of Michigan, a most careful system must be followed to realize profit.

Fertilizers Recommended

Fertilizers for oats and barley are recommended as follows:

Soils	No mixed meadow, manure, or green manure in rotation		Mixed meadow, clovers, alfalfa or soy beans in rotation		Manure in the rotation	
	Not to be seeded	To be seeded	Not to be seeded	To be seeded	Not to be seeded	To be seeded
Light sandy loams	4-12-0	3-12-4	0-16-0	0-12-6	0-16-0	0-16-0
Loams, silt loams and clay loams	2-16-2	2-16-2	0-16-0	0-16-0	0-16-0	0-16-0

It is to be seen that the general farm practice has much to do with fertilizer to be used. These recommendations take into consideration the prevailing lack of phosphorus in our soils. The light sandy loams are usually low in nitrogen unless this has been supplied by manures or the growing of legumes. Leguminous crops for hay following oats or barley respond to the application of potash. The amount of these fertilizers to be applied depends on the extent to which the soils have been cropped and the system of management which is in practice to maintain the fertility of the soil. For soils of ordinary fertility, the fertilizers recommended give excellent results when applied at the rate of 200 to 300 pounds per acre.

Increased yields of oats and barley should result from the treatment which has been outlined. This increase can be profitably brought about through labor saving tillage methods and the proper use of commercial fertilizers.

SPRUCE AND BALSAM FIR IN THE UPPER PENINSULA

Soil Areas in the Upper Peninsula May Be Utilized for Pulpwood Production

BY WILSON MARTIN, FORESTRY SECTION

During the summer of 1925, data were gathered on a logged-over area of spruce and balsam. This area contains 40 acres and lies along the south boundary of the Dunbar Forest Experiment Station. The site is a stony bench with large boulders strewn about. The soil is glacial washed gravely loam and is typical of one of the types found in the Upper Peninsula of Michigan.

At present the area is fully stocked with spruce about four feet tall. A study of the following tables compiled from the data gathered shows the rate of growth of the two species up to 60 years. The table is based upon measurements on 400 trees collected by Professor A. K. Chittenden in 1925.

Height and Diameter Growth of Spruce and Balsam

Age years	Spruce		Age years	Balsam	
	Average D. B. H.* inches	Average height feet		Average D. B. H.* inches	Average height feet
	Inches			Inches	
15	1.2	9.2	15	1.2	10.5
20	2.0	12.4	20	2.2	15.5
25	2.7	15.1	25	3.2	20.8
30	3.7	19.4	30	4.2	26.0
35	4.6	23.0	35	5.3	31.6
40	5.6	27.2	40	6.3	37.0
45	6.7	32.3	45	7.3	42.5
50	7.7	37.0	50	8.4	48.5
55	8.8	42.2	55	9.4	54.1
60	9.8	47.1	60	10.6	62.5

*D.B.H. "Diameter Breast High" is commonly used in forestry to indicate diameter at 4½ feet above the ground.

The balsam has kept ahead of the spruce in diameter and height growth. The average growth for each five-year period is as follows:

Spruce: Averave D. B. H. growth for each five-year period: .95 inches—height growth, 4.32 feet.

Balsam: Average D. B. H. growth for each five-year period: 1.04 inches—height growth, 5.77 feet.

At sixty years the volume of the average tree in cords of pulpwood is: Spruce: .030 cords. Balsam: .039 cords.

In a preliminary study of white spruce made by Kenety* in Minnesota where the soil, rainfall, humidity, and temperatures are closely correlated with that of the Upper Peninsula of Michigan, some interesting data were given on stocking and yield.

On the very heavy clay soils of the Upper Peninsula a growth similar to that found in the Minnesota study would not seem unreasonable. On an average acre measured, there were 560 trees, 295 were over 3 inches in diameter and the average was 5.1 inches. The average age was 28 years. This acre contained 11¾ cords of merchantable pulpwood. If the same rate of growth was continued the average tree should be ten inches D. B. H. in—between 50 and 60 years. This would produce about 50 cords of pulpwood per acre.

In a region where the water table is near the surface, the heavier soils are occupied by balsam, fir and popple. On the lighter soils under these conditions, white spruce under management should yield between 75 and 90 cords of pulpwood in 90 years. At this age there should be 400 trees per acre between ten and eleven inches D. B. H. At thirty-five years there should be 850 trees to the acre and would yield about thirty cords of wood per acre.

There is a type of clay soil in the Upper Peninsula which is very fine textured allowing water to pass through it very slowly. It supports a dense growth of scrub maple, alder and hazel brush. This soil is particularly adapted to white spruce. Under management, with 680 trees to the acre, there should be a yield of fifty cords of pulpwood in forty-six years, including the thinnings. On types of soil where it is possible to grow spruce at a profit, it is to be preferred to balsam fir. On those sites too wet for spruce, balsam may be used as a crop to furnish pulpwood. The demand for balsam fir is constantly increasing.

SOIL PREPARATION AND FERTILIZATION FOR CORN

Lower Unit Costs in Corn Production Increases Profits from Crop

C. E. MILLAR, SOILS SECTION

A lower cost per bushel which may be obtained by producing larger yields per acre will give the greatest profit in corn growing. This principle has been amply demonstrated by the experience of many farmers as well as by experimental results from the Michigan, Ohio, Indiana, and other experiment stations.

To produce large yields it is necessary to supply an abundance of plant food in the form of barnyard manure or commercial fertilizer or both. A properly balanced fertilizer will hasten the growth and maturity of the crop, thus avoiding frost injury and giving a better

*University of Minnesota bulletin No. 168, June 1917—"Preliminary Study of White Spruce in Minnesota."

quality of grain. Late planting made advisable to avoid corn borer injury may be compensated for to a considerable extent by suitable fertilization, according to experimental results from Ohio.

Thorough fitting of the seed bed with the soil well compacted to the depth of plowing is important in growing a bumper crop. Many weeds may also be destroyed by pre-planting cultivation.

Fitting the Seed Bed

Careful plowing is the first and one of the most important steps in producing a profitable corn crop. While fall plowing is desirable, especially on the heavier types of soil, spring plowing is very satisfactory if done early. Fall plowed land should not be worked until spring as the rough surface is advantageous in catching snow and in preventing the washing of rolling land by early spring rains.

After plowing, further fitting of the ground should have as its object the compacting of the soil to the depth of the furrow slice with the production of a mellow but not too loose surface layer for receiving the seed. On fall plowed land, this condition may be brought about by frequent working with a disk or spring tooth and in extreme cases by use of the roller. Spring plowed ground requires more working to get it into the best condition. Some successful corn growers prefer to roll immediately after plowing and to follow the roller with the disk or spring tooth. Other producers considered it advisable to use the disk before rolling. It cannot be denied that a disk set fairly straight has a great settling effect on freshly plowed ground.

On both fall and spring plowed land cultivation should be repeated at frequent intervals from early spring until planting time as this is the farmer's opportunity to destroy weeds at a minimum of expense. Cultivation before planting is much more economical than inter-row tillage and when weeds are destroyed by this method the amount of cultivation required after the crop is up may be considerably reduced.

Quite frequently, corn follows sweet clover, rye, or other crops seeded especially for the purpose of adding green material to the soil. Under these conditions, plowing should be delayed as long as practicable in the spring in order to allow for a maximum growth of the green manuring crop. Plowing must not be delayed too long, however, or the corn crop will suffer. As soon as the ground is plowed it should be rolled and disked or spring toothed several times in order to get it compacted and into shape as rapidly as possible.

The Kind of Fertilizer to Use

Corn responds especially well to fertilization with barnyard manure. In a number of experiments conducted in various parts of the state by the Soils Department, manure has proved more satisfactory than any other fertilizer tested. Unfortunately, the amount of manure on most Michigan farms is limited and very often the farmer wishes to use some of the supply on potatoes and beans as well as on corn. It has been found that supplementing the manure with commercial fertilizer is a very satisfactory practice. Acid phosphate is the best material to use for this purpose because it supplies the plant food in which the manure is most deficient, namely phosphoric acid. This has the effect

of balancing the plant food situation and so allowing the corn to make use of the available nitrogen and potash in the manure to far better advantage.

Acid phosphate has another value aside from making the manure a better balanced fertilizer, and that is its ability to hasten the maturity of the crop. In a climate where there is always danger of the corn being caught by an early frost, the use of a fertilizer which will ripen the crop early is very important. When it is necessary to delay planting in order to avoid ravages of the corn borer, it is possible to overcome the handicap to a considerable extent by hastening maturity with fertilizers carrying high percentages of phosphate. The fertilizer should be placed in the hill or row in order to get the greatest effect in hastening maturity, according to Ohio results.

When the supply of manure is very limited, it is often advisable to use a fertilizer carrying ammonia or ammonia and potash in addition to phosphoric acid. When the humus supply of the soil is low, a fertilizer containing from 2 to 4 per cent of ammonia and 12 per cent of phosphoric acid is desirable. If the soil is rather sandy and in cases where a heavy soil is low in fertility, it is usually best to supply some potash also. A complete fertilizer having a 2-16-2 composition meets the requirements nicely. In cases where the soil is in an especially poor state of fertility, it may be necessary to use a 3-12-4 mixture.

How to Apply the Fertilizer

When acid phosphate is used in conjunction with manure, it may be mixed with the manure as the stables are cleaned out. There is an added advantage in this practice in that the phosphate serves as a preservative and so prevents loss of ammonia and organic matter, especially if the manure is not to be applied at once. Sprinkling from 30 to 40 pounds of phosphate in each load of manure as it is thrown on the spreader has also proved a good practice when no phosphate was used in the stable.

When mixed fertilizer is used to replace all or part of the manure, the fertilizer may be either spread over the entire surface of the field and dragged in or drilled in the rows or hills. From the standpoint of the crops which are to follow the corn the general application is the better since the residues of fertilizer will be evenly distributed over the field. When this method of application is used a somewhat larger application of fertilizer should be made; from 200 to 300 pounds per acre being a reasonable application. In case the hill method of application is preferred, the amount of fertilizer should be cut to about 125 pounds per acre as larger amounts may result in damage to the sprouts due to the fertilizer being dropped with or very near the seed. With the fertilizer drilled along the row, as much as 200 pounds may be used without damage.

The opinion sometimes expressed that fertilizer dropped in the hill or row will limit the root development of the corn has been proved unfounded by a number of experiments. More fibrous feeding roots will develop in the vicinity of the fertilizer but the extension of the main root system through the soil and the consequent water absorbing power of the plant will not be limited and in some cases may be increased.

FITTING AND FERTILIZING SOIL FOR SUGAR BEETS

Deep Plowing Essential for Proper Fitting of Seed Bed for Sugar Beets

J. D. ROMAINE, SOILS SECTION

Sugar beets are an important cash crop in Michigan. High yields must be obtained to realize maximum profits since the costs of labor and other production factors are considerable. The main points to be considered to secure a profitable crop are careful and correct seed bed preparation, the application of correct kinds and amounts of fertilizers, and sufficient amounts of lime in the soil.

Experience in growing sugar beets has shown that one of the principle cultural essentials of this crop is a well prepared seed bed, because sugar beets respond profitably to proper methods of seed bed preparation when these methods can be made effective. It is usually not possible to prepare an *ideal* seed bed for a root crop, but if good results from the time and labor expended in preparing the soil are to be obtained certain factors that have to do with the preparation of good seed beds must be considered.

In order to secure a seed bed of sufficient depth for the proper development of sugar beet roots, the land should be plowed six or more inches deep. This depth of plowing will tend to liberate more plant food than shallower plowing and the young sugar beet plants will get a good start in growth. A seed bed of the proper depth will also allow the beet roots to grow deeply into the soil and to take on a good shape.

When the beet roots grow deeply into the soil, the bad effects due to drought injury are not so apparent. Well shaped roots lessen topping and tare wastes and are more conveniently handled in the process of sugar extraction at the sugar factory. However, care should be taken not to plow too deeply, not more than about an inch deeper than the previous plowing depth, as the raw subsoil is usually not as fertile as the surface soil, therefore, the turning up of too much of the subsoil at one time may materially decrease the crop yield.

Time To Plow

Some consideration should be given to the best time for plowing land for sugar beets. If the soil is in poor structural condition, or if the land tends to be wet in the spring, due either to poor drainage or unfavorable weather conditions, the best time to plow this kind of land is usually in the fall preceding the beet crop. This procedure will usually bring about improvement in the soil structure due to winter freezing and better soil drainage conditions in the spring, thus allowing for earlier tillage operations and hence earlier seeding. In general, fall plowing is advisable on heavy soils that are not tile

drained, but well drained soils may be plowed either in the fall or spring. Fall plowing may be done more deeply than spring plowing; and fall plowed land should be left in a rough condition until spring.

After plowing, and in order to produce a fine and fairly compact seed bed, the land should be well worked with harrows, using a roller if necessary to crush lumps and compact the soil. Cultivating or otherwise working the soil after the crop comes up is usually limited to the amount necessary to keep down the weed growth. In case the soil is ridged considerably by blocking and thinning the beets, it will sometimes be profitable to smooth and compact the soil surface by means of a cultipacker or roller.

Fertilizing the Crop

The main points to be considered in fertilizing the sugar beet crop are the application of the proper kinds and amounts of fertilizers, and the best methods for making the applications.

The best amount of fertilizer to apply to the sugar beet crop depends somewhat upon local soil conditions. It is usually not profitable to apply too much fertilizer, although the common tendency is to apply too little fertilizer to most economically utilize the full productive value of the soil. According to the results of closely controlled fertilizer experiments carried out by the Soils Department on the sugar beet crop and on typical sugar beet soils, an application of 300-400 pounds of commercial fertilizer per acre has given, in general, the greatest profits.

A question is often asked concerning the relative merits of broadcast and row application of fertilizers for sugar beets. Experiments being carried out are showing that for moderate applications of fertilizers, 300 pounds per acre or less, the application of the fertilizer in the row by means of the fertilizer attachment on the beet seeder gives satisfactory results. For heavy applications of fertilizer, however, broadcasting a part of the fertilizer usually gives better results than applying all of the fertilizer in the row; even though an extra operation is required for the broadcasting.

Local soil fertility conditions and cropping systems also influence to a great extent the best kind of fertilizer to apply to sugar beets. It has been observed however, that many farmers use fertilizer mixtures which apparently are not the most profitable kinds and the exercise of greater care in the selection of fertilizers is suggested to them. Only high grade commercial fertilizers, which are those containing 14 per cent or more of total plant foods as shown by the fertilizer analysis, are recommended for use in Michigan.

On soil adapted to sugar beets, 16 per cent acid phosphate usually has given the most profitable returns on the money invested in fertilizer. On soils rather low in fertility or lacking in organic matter content, the use of a 2-16-2 or 3-12-4 fertilizer is suggested. Concerning the use of barnyard manure on sugar beets, experience teaches that it is usually more profitable to apply the manure to a crop preceding the sugar beet crop, such as corn. If manure is used on some other crop in the rotation, it is considered advisable to apply only acid phosphate fertilizer for the beets.

If the soil is too acid to grow clover and alfalfa successfully, lime should be applied, as beets do better on a soil that is not too acid. However, before adding lime, the soil should be tested to determine if it needs lime, and if so, how much.

RANGE PARALYSIS OF POULTRY

H. J. STAFSETH AND E. P. JOHNSON, BACTERIOLOGICAL SECTION

In the fall of 1921, numerous inquiries began to come to this laboratory regarding a disease of poultry appearing in various parts of this and other states in the form of legweakness, paralysis, incoordination of movements, and emaciation. Some birds showed blindness and it was thought that this manifestation was a symptom of the same trouble. Since then, this disease has increased in prevalence so that it may be safely said that it is now the most serious ailment affecting birds from four to fourteen months of age.

Our experimental, routine, and field work has showed that legweakness may be a symptom of tuberculosis, sarcomatosis, bacillary white diarrhea, fowl cholera, worm infestations, nutritional disturbances, botulism, and coccidiosis, but we became convinced that a certain pathogenic agent must be responsible for the very prevalent disease in poultry which appears in young stock during the late summer, fall, and early winter months. As only a comparatively small number of the birds examined showed worm infestation of any serious nature, we were forced to disregard worms as the actual cause of this disease. Numerous attempts at cultivating a specific bacterium from the tissues of affected birds failed except in a few cases in which already well known infectious diseases occurred. Negative results have also been obtained from numerous attempts at transmitting the disease directly from diseased to healthy birds by feeding or inoculation of cultures, tissue extracts, and intestinal contents as well as by cage exposure except in one case in which a strain of **Pasteurella aviseptica** was found, which caused legweakness following injection, feeding, and cage exposure and in the experiments to be recorded in this article. It has also been found that the feed is not responsible for this disease, at least, as it occurs in Michigan and Northern Ohio.

Autopsy Provides Clue

On Aug. 25, 1926, a bird showing typical symptoms of legweakness was sent in for examination. This bird came from a flock that had been given cod liver oil as a part of the daily ration. The autopsy revealed the presence of a few small tapeworms. For this reason, the intestines were turned over to Dr. W. L. Chandler (parasitologist at this station) for identification of the worms. A few moments later **Dr. Chandler informed us that, besides a few tapeworms (Davainea cesticillus), innumberable coccidia were found in the duodenal mucosa.**

He also called our attention to the fact that these coccidia occurred in "colonies" visible to the naked eye in the form of minute grayish or yellowish white streaks or points thickly and evenly distributed over the mucous membrane of the duodenum. Such lesions some of which can be seen through the serosa, had been observed before, but, for various reasons, no serious thought had been given to coccidia as being the cause of these lesions or the disease under investigation.

In view of our previous experience with experimental and field work on so-called range paralysis and the fact that coccidiosis cannot be transmitted directly from one bird to another by feeding or inoculation, the coccidia requiring an incubation period of about four days under suitable conditions outside the body of the bird for development to an infective stage, it was decided to undertake some experiments to determine the relation of coccidial infection to range paralysis. Thus, on Aug. 31, a pen of 12 presumably clean birds was made up and these birds were fed incubated or sporulated coccidia in bran mash Aug. 31, Sept. 1, Sept. 6, Sept. 17, Oct. 10, and Nov. 27. On Sept. 29, one cockerel was found to be very lame after having showed incoordination for two or three days. On October 4, this bird was completely paralyzed and was killed.

The autopsy revealed a typical and very severe case of duodenal coccidiosis. There were no signs of any other disease. Since then five more of the twelve birds have come down, one with paralysis, one with slight incoördination, and the others with marked emaciation. All six birds showed duodenal coccidiosis in various stages, and only one bird had worms (ascarids). This bird had showed marked emaciation for several days without showing any other symptoms.

These birds were fed mash and whole grain and were also given green feed. They were housed in small colony houses that were provided with yards on the south side. In three adjacent pens over fifty chickens were kept a few of them for more than one year, all receiving the same rations as those on the coccidiosis experiment and not a single case of the disease under investigation has been recorded in these pens. This experiment and the results of autopsies on birds sent in for examination since Aug. 25, 1926 indicate that duodenal coccidiosis infection is the most important cause of an ailment in poultry commonly spoken of as legweakness, range paralysis, turning diseases, or going light.

After having found that the coccidia may localize rather deeply in the mucous membrane of the duodenum it became possible to establish a positive diagnosis of coccidiosis in cases in which formerly no known pathogenic agent could be demonstrated.

Symptoms

Since most poultry owners are very well acquainted with the symptoms of this disease and since the common names given above are quite descriptive the symptoms will not be discussed in this article.

Lesions

In most birds no lesions will be found except in the duodenum which always shows inflamation. At times this inflammation is catarr-

hal with more or less thickening of the mucosa. Then again there may be hemorrhagic duodenitis. A rather common lesion in advanced cases is sloughing of the mucous membrane. The most characteristic and most easily recognized form of enteritis observed in this disease is catarrhal inflammation with thickening of the mucosa which also shows numerous grayish or yellowish white streaks or spots marking the necrotic areas produced by large numbers of coccidia undergoing asexual reproduction of schizogony. Enlargement of the sciatic nerve is sometimes found. Necrotic spots and areas as well as hemorrhages have been observed in the liver but the significance of these lesions is not yet definitely known.

Diagnosis

As legweakness or similar manifestations occur in a number of diseases one cannot always determine the cause unless a rather careful examination is made of a number of the birds affected. The demonstration of duodenal inflammation by post mortem examination may be suggestive of coccidiosis if there are no signs of other known poultry diseases. A final diagnosis will rest on the demonstration of one stage or another of the coccidium in the intestinal contents or in the mucous membranes of the intestines. In some stages of the disease oocysts will be found while in others no oocysts seem to be present. However one may find numerous intracellular stages such as trophozoites, schizonts, macrogametocytes or macrogametes. If sloughing of the mucous membrane has taken place few coccidia may be found. Several cases have showed no coccidia in the ceca. The coccidium most frequently encountered is 10-15 microns long sometimes round and sometimes more or less elliptical. In stained sections the merozoite has also been observed. Such preparations also show that the coccidia invade the epithelial cells lining the crypts of the mucosa, the invasion at times extending more than half way to the serous membrane.

Treatment

It is questionable whether any treatment, known at this time, can be considered a specific cure for this disease. However, within recent times two new treatments have been suggested both of which seem deserving of further trial. One consists in putting one teaspoonful of quinine sulphate into each gallon of drinking water keeping this solution before the birds while the disease exists in the flock. As quinine sulphate is expensive and only slightly soluble in water one should add fresh water as needed until all of the drug is entirely dissolved before adding a new dose. The water must of course, be protected so that it cannot be contaminated with droppings. Isolation and treating of affected birds only, may prove effective and, surely, more economical than treating the entire flock provided the apparently healthy birds are placed in clean quarters or on entirely fresh ground.

Iodine vermicide in one ounce doses for adult birds should also be given a trial as there are reasons to believe that it may be of value in treating coccidiosis. This drug is given by means of a one ounce infant enema syringe attached to a female catheter No. 5, the catheter being passed down the espohagus directly into the gizzard.

Prevention

As is the case with contagious diseases in general, prevention is more important than the cure. Those who insist on raising poultry on the same ground year after year will sooner or later suffer great losses from this or other communicable diseases. This will often be the case even if an attempt is made at turning over the ground as this is not an effective way of removing heavy soil infection. A better system is a systematic annual rotation of poultry runs supplemented by frequent turning over of the soil. Where the ground has become excessively contaminated it may be necessary to put the birds on cement runs for the purpose of making cleaning and disinfection possible.

Those who expect to stay in the poultry business for some time should consider nothing but concrete floors for the houses as these, when properly constructed, are the only ones that can be disinfected if occasion should ever require. It is quite evident that proper disinfection cannot be practiced in many poultry houses.

Some arrangement should also be made for keeping the birds away from the dropping boards and also for keeping the feed and water free from contamination with droppings. It may also become necessary to discontinue feeding scratch feed in the litter as this practice certainly increases the amount of contamination taken in with the feed.

Care of Infected Flocks

In the case of an outbreak of coccidiosis on any poultry farm the healthy birds must be removed from contaminated ground. If absolutely fresh ground is available, they may be moved there, if not, they should be placed on cement runs or closed up in a house with concrete floor. Then, remembering that several of the apparently healthy birds may be discharging the infection with the droppings one should practice the following routine as regards house management: Remove all litter and droppings, scraping the floor, every fourth day: In mild outbreaks it may be sufficient to do this once a week. There is of course no objection to cleaning every day, if so desired. The litter and droppings, removed from the house, must not be left in a place accessible to poultry as is often done. Burning is practically the only safe means of disposal of such material. It should not be forgotten that coccidia are very resistant and may remain in the ground for a long time without being destroyed.

Following the mechanical cleaning of the house, flood the floor with iodine suspensoid diluted 20 times with water using two gallons of diluted suspensoid to 100 square feet of floor space. While applying this solution, scrub thoroughly with a stiff brush. Immediately following, apply one more gallon of diluted suspensoid to each 100 square feet or floor space and scrub carefully. The dropping boards should also be treated in this way if the birds have access to them.

If the suspensoid is obtained in five gallon jugs or carboys care must be taken to shake the carboys quite vigorously for at least ten minutes in order to get the drug which settles to the bottom during prolonged standing, back into suspension. If this is not done, the one to twenty solution will be too weak and the desired results will not be obtained.

During the outbreak of coccidiosis, the iodine should be applied once a week. It may also be well to give the entire flock iodine vermicide as suggested adove. A repetition of this treatment after four to eight days might prove profitable. To treat badly affected birds is deemed useless.

Study of Disease Continues

Work on this disease is being continued both as regards etiology and therapy. The above suggestions as to treatment and, more particularly, prevention of so-called range paralysis is given in the hope that a system of sanitation based on our present knowledge of coccidiosis may be of some value to the poultry industry. This was thought justifiable since we have been able to show that duodenal coccidiosis and leg weakness, range paralysis, or synonomous diseases are at least closely related. The treatment with iodine vermicide is essential for the removal of worms, as these, when present, will surely aggravate the disease and may possibly cause leg weakness unaided if present in large numbers. It may also prove beneficial in the early stages of the disease, since we have proved experimentally that it will kill coccidia in vitro.

Other publications from this station on Coccidiosis, its prevention and cure will be found in Mich. Agr. Exp. Sta. Quarterly Bulletin for Aug. 1923 and Jour. Am. Vet. Med. Association for August 1926.

POSITION ON RIDGE AFFECTS CONIFERS GROWTH

Rapidity of Growth Affected by Moisture Holding Capacity of Soil

BY A. K. CHITTENDEN AND WILSON MARTIN, FORESTRY SECTION

A forest plantation was established in 1913 on a sand ridge at East Lansing. The plantation covers 2.5 acres. The ridge is long with a gentle slope on the south side and a steeper slope on the north side. The trees were planted on the top of the ridge and on the north slope to the bottom. The difference in elevation between the top and bottom of the ridge on this side is about fifteen feet. The soil on the top of the ridge is very light sand, drying out quickly after a rain. The soil at the base of the ridge is also sandy but contains more humus and holds more moisture than at the top. The trees which were three or four years old at time of planting were spaced 4 by 4 feet. The plantation is now 14 years old. They were planted by species in solid blocks, consisting of white pine, western yellow pine, and Norway spruce.

The following table shows the rate of growth in the two locations for the three species:

Height growth of white pine, western yellow pine and Norway spruce on the two sites.

Year	White pine		Western yellow pine		Norway spruce	
	Bottom of ridge, feet.	Top of ridge, feet.	Bottom of ridge, feet.	Top of ridge, feet.	Bottom of ridge, feet.	Top of ridge, feet.
1926	19.9	13.7	15.5	15.1	17.6	7.7
1925	18.5	12.0	15.3	13.3	15.7	7.3
1924	17.2	10.6	14.0	12.3	14.0	6.6
1923	15.0	9.3	11.7	10.7	12.2	6.0
1922	12.7	7.7	9.9	9.1	10.4	4.9
1921	11.0	5.7	8.3	7.3	8.6	4.5
1920	8.0	4.6	7.7	5.7	6.4	3.9
1919	6.9	3.4	5.8	4.2	4.9	3.2
1918	4.9	2.7	4.1	3.0	3.9	2.6
1917	3.3	2.1	2.8	2.3	3.1	1.8
1916	2.3	1.6	2.0	1.6	2.5	1.5
1915	1.8	1.3	1.2	0.9	2.1	1.1

The table shows that the western yellow pine is least affected by the dryer soil. There is very little difference in height growth of this species on the two sites. It has also made the best diameter growth of the three species although diameter growth is not shown in the table.

The white pine has grown faster upon the more moist site than on the dryer soil, but the greatest difference is shown in the case of the Norway spruce which has grown over twice as rapidly in height upon the more moist location than on the dryer site. This would indicate that the Norway spruce is not so well adapted for planting on dry sandy soils as the other two species. It appears to be healthy but its slow growth under such conditions would make its planting less profitable except for Christmas trees where too rapid growth is not desirable.

PRODUCTION TEST OF COMMERCIAL SUGAR BEET SEED

Wide Variation Found in Yields from Sugar Content of and Sugar Produced by the Beets from Different Brands of Seed

The Results of a Test of 44 Different Brands of Commercial Sugar Beet Seed, 1926

J. G. LILL, FARM CROPS SECTION

This test was conducted at the Michigan State Experiment Station at East Lansing, Michigan, and this report gives the results obtained under the field, soil, and seasonal conditions surrounding it.

The date of planting was unusually late; one third of the test (including all 44 different brands) having been planted on June second; one

third on June twenty-third; and one third on June twenty-fourth. Inasmuch as each brand of seed tested was equally represented in each date of planting, the results are believed to be comparable.

The results given in this report were obtained by a compilation of the fifteen different determinations (five from each date of planting) that were made for each brand of seed tested. A standard brand of seed (J. Zapotil II.) was planted in every third plot as a check on variations caused by the fertility of the soil or other factors. The variations in the stand, yield, sugar content, purity and amount of sugar produced per acre, shown by this standard have been fully considered in the preparation of this report.

The results herein given, have been reduced to a direct comparative basis by approved statistical methods. The significance of the differ-

Table I.—Shows the number of times that each brand of seed tested equalled or exceeded the results obtained from the standard seed grown beside them in the fifteen determinations which were made with each brand of seed.

Planting order*	Brand—Designation	In stand per acre	In tons per acre	In sugar content	In purity	In sugar per acre
42	J. Zapotil 1-31, (1924 seed)	10	14	6	5	11
17	Uladovsk YS II	10	11	4	1	10
43	Schreiber's "S. S.", (1924 seed)	11	12	1	8	11
31	R. & G. Normal (Original)	7	9	5	5	6
16	J. Zapotil II**	11	8	10	9	8
39	Dobrovice Original (1924 seed)	7	7	11	6	6
26	Deutsch Tcheco	10	9	13	9	9
24	R. & G. Old Type	9	8	2	5	7
19	R. & G. Pioneer Brand	11	9	8	6	9
38	J. Zapotil II-33 (1924 seed)	10	8	10	9	8
27	Schreiber's 'S. K. W"	11	8	2	8	7
30	Vilmorin (Andrieux)	8	8	2	4	6
25	Productive Super Elite	14	4	14	10	4
12	Granum Brand	10	4	7	7	5
33	(omitted by request)	8	6	8	8	7
15	U. D. Y. C. Z	9	5	12	8	6
23	Schreiber's "S. S."	6	9	2	3	5
10	Kalniki IV	11	5	10	4	5
1	Strube	9	9	8	10	8
44	S. W. H. N	5	3	13	9	4
28	(Omitted by request)	11	5	11	8	5
35	R. & G. Extreme Pioneer	8	3	11	11	2
2	Productive Super Elite**	9	4	13	14	5
21	Erhard Frederiksen CMB Strain	5	6	0	3	3
40	Braune Elite (1924 seed)	9	5	1	4	2
4	Deutsch France	11	5	6	5	3
7	Ivanovsk R. M., I	8	6	2	2	4
11	Improve Vilmorin, Selection A	10	3	6	5	4
32	Martin Brand (Ceres)	4	2	6	3	2
9	Canadian Grown	13	4	5	6	4
8	Improved Vilmorin, Selection B	6	6	0	2	4
34	Ivanovsk S., III	7	2	10	9	2
14	Maximale—Buszczynski	4	2	14	9	2
5	Improved Brabant Green Top	8	11	0	1	3
3	Horning	10	4	7	4	4
41	Rimpau Original (1924 seed)	7	1	14	6	2
29	"M. I."	10	0	15	12	2
36	Despres Brand	7	2	11	11	2
22	La Graine Selectionee	10	1	3	1	1
18	Sebline	4	2	5	2	1
20	La Fontaine	5	1	4	3	1
37	Glostrup Brand (1924 seed)	5	3	2	2	2
6	(Omitted by request)	5	2	1	4	1
13	Francaise Riche	4	3	1	5	1

*The standard brand was not given a number. It was planted in every third plot—before No. 1, between 2 and 3, etc.

**Sample from different sources.

Table II.—The results of the test showing the stand, the yield, the sugar content, the purity, and the pounds of sugar produced per acre, of the beets grown from each brand of seed tested.

Planting order	Brand—Designation	Beets per acre at harvest	Yield, tons per acre	Sugar content percent	Purity factor percent	Sugar per acre, pounds
42	J. Zapotil I-31 (1924 seed)*	22330	7.927-C	16.81	88.75	2658-A
17	Uladovsk YS, II	22367	7.681-A	16.49-B	87.13-C	2530
43	Schreiber's "S. S." (1924 seed)	23009	7.614-A	16.41-D	89.05	2484
31	R. & G. Normal (Original)	21724	7.351	16.79	88.56	2456
16	J. Zapotil II	22257	7.195	17.10	89.74	2447
39	Dobrovice Original (1924 seed)	20663-A	7.041	17.16	89.57	2402
Check	Average of 355 determinations	22111	7.047	16.974	89.351	2383
26	Deutsch Tcheco	23575	6.908	17.25-A	89.65	2375
24	R. & G Old Type	22591	7.180	16.55-D	88.60	2373
19	R. & G. Pioneer	23690-A	6.989	17.03	88.53	2367
38	J. Zapotil II-33 (1924 seed)	23091	6.904	17.14	89.72	2355
27	Schreiber's "S. K. W."	23929	7.172	16.39-D	88.49	2346
30	Vilmorin (Andrieux)	22659	7.131	16.45-B	88.46	2337
25	Productive Super Elite	24419-C	6.583-A	17.64-D	90.07	2314
12	Granum Brand	23833	6.786	17.02	89.40	2300
33	(Omitted by request)	23718	6.790	16.97	89.72	2292
15	U. D. Y. C. Z.	20762	6.499	17.43-C	89.38	2275
23	Schreiber's "S. S."	21927	6.932	16.39-D	88.35-D	2263-A
10	Kalniki IV	23588	6.582-A	17.13	88.21	2247
1	Strube	22151	6.623	16.81	89.91	2232
44	S. W. H. N.	20439	6.375-B	17.60-B	89.95	2227-A
28	(Omitted by request)	22810	6.494	17.08	88.89	2223
35	R. & G. Extreme Pioneer	22281	6.442-B	17.27	90.36-A	2217-B
2	Productive Super Elite**	21618	6.174-B	17.94-D	91.23-D	2212
21	Erhard Frederiksen CMB Strain	21375	6.770	16.39-D	87.79-B	2207-A
40	Braune Elite (1924 seed)	22958	6.776	16.27-D	88.39	2187-A
4	Deutsch France	23106	6.515-A	16.87	88.94	2186-A
7	Ivanovsk R. M., I	22222	6.717	16.34-D	87.25-D	2182-A
11	Improved Vilmorin Selection A	22803	6.536-B	16.64	88.89	2175-B
32	Martin Brand (Ceres)	20729	6.495-D	16.63-A	88.06-B	2161-D
9	Canadian Grown	24702-B	6.518-A	16.72	87.90	2158-A
8	Improved Vilmorin Selection B	21244	6.771	16.01-D	87.64-C	2144-B
34	Ivanovsk S. III	22790	6.265-D	17.16	89.02	2143-C
14	Buszczynski's) Maximale	21092	6.008-B	17.75-C	89.58	2127-A
5	Imp. Brabant Greentop	22595	7.485-A	14.34-D	85.88-D	2120-D
3	Horning	22186	6.278-A	16.91	88.57	2116-A
41	Rimpau Original (1924 seed)	21494	6.087-D	17.42-D	88.94	2108-B
29	"M. I."	22790	5.865-D	17.97-D	90.28	2096-D
36	Despres Brand	20932	6.034-D	17.40-A	90.57-D	2092-D
22	La Graine Selectionee	23146	6.214-D	16.81-A	88.31-A	2079-D
18	Sebline	20793-A	6.195-D	16.67	88.11-B	2064-D
20	La Fontaine	20877	6.094-D	16.76-A	87.80-B	2034-D
37	Glostrup Brand (1924 seed)	21067	6.196-B	16.24-B	88.49-A	2022-C
6	(Omitted by request)	20340-A	6.049-D	16.27-D	87.78-A	1961-D
13	Francaise Riche	20320	6.166-B	15.77-D	88.36-A	1934-D

*All brands not otherwise marked supposed to have been 1925 seed.

**Sample from different source.

***Chemical work performed by the Chemistry Section of the Agricultural Experiment Station.

Explanation of Symbols:

Where the results secured in this test differ from the results given by the standard brand of seed used, the significance of the difference is indicated by symbols. The significance is stated in odds of a certain size to 1 that the difference between the result given and the standard was not due to chance alone but was therefore, probably due to some quality of the seed tested.

No symbol	Odds about even.
A	At least 30 to 1.
B	At least 100 to 1.
C	At least 500 to 1.
D	At least 1,000 to 1.

ence of any result from the result given by the standard has been determined by "Student's Method" of statistical analyses.

No figure or result is significantly different from the result given by the standard unless so indicated by the letter following the result given.

In table II, the columns of results given will not cross-check as each result given in each column has been compiled from the fifteen original determinations. That is, the sugar produced per acre was determined from the yield and sugar content of the sugar beets produced on each of the fifteen different plots of each brand of seed tested. As the yield and sugar content of the sugar beets from the different plots varied, the average yield and average sugar content for the fifteen different plots will not necessarily give the same amount of sugar per acre as the average of the fifteen different determinations of the amount of sugar produced per plot.

"THE McNAUGHTON SYSTEM" OF CURING BEANS

This System Lessens Weather Damages, Permits Sowing Bean Fields to Grain

H. R. PETTIGROVE, FARM CROPS SECTION

Bean growing in many northern communities has been rendered very hazardous during seasons of adverse weather. The past two falls furnished very good examples of the effect of bad weather on beans. In the fall of 1926, many bean crops were ready to haul into the barn or to thresh from the field when a shower prevented the handling of the crop. Such spasmodic rains make necessary the frequent turning of beans which have been pulled. This is expensive in terms of dollars and cents for labor, to say nothing of the loss caused by actual damage to the beans.

Many farmers plan to plant their bean fields to wheat if the beans are harvested in time. Frequent rains usually delay getting the beans off the ground until it becomes too late to sow the wheat, or cause the wheat to be sown at such a late date that loss in yield due to winter killing may result.

"The McNaughton System" of curing beans makes it possible to successfully harvest beans even during adverse seasons at a moderate additional expense per acre. This system will make bean growing in Michigan more secure.

This method of curing beans is called "The McNaughton System" because Mr. O. J. McNaughton of Mulliken, Michigan, was the first to use the method on a field scale in Michigan. A similar method is employed in southern states to cure peanuts, soybeans, and cowpeas.

In employing "The McNaughton System," the beans are pulled, when ripe, with the bean puller and thrown into a windrow with the

side-delivery rake, there being two pulled rows or four bean rows in a small windrow. Two of these windrows are generally thrown together, making eight bean rows in one large windrow.

After the beans are in windrows they are stacked four windrows at a time. A wagon loaded with straw and carrying steel fence posts or poles is driven across the field between two of the large windrows. The first post is set about two and one-half rods in from the end, the rest being set at intervals of four or five rods.

A steel fence post seven feet long is a good type to use. It makes a very substantial post and is the right height for a stack. Poles can be used but they must be strong. Whatever type of post is used, it must be well set to prevent leaning.

The post having been driven into the ground, a fork full of straw is placed around it. The straw should form a pad about four feet in diameter and four to six inches thick when settled.

The beans in the four windrows are collected with pitchforks and

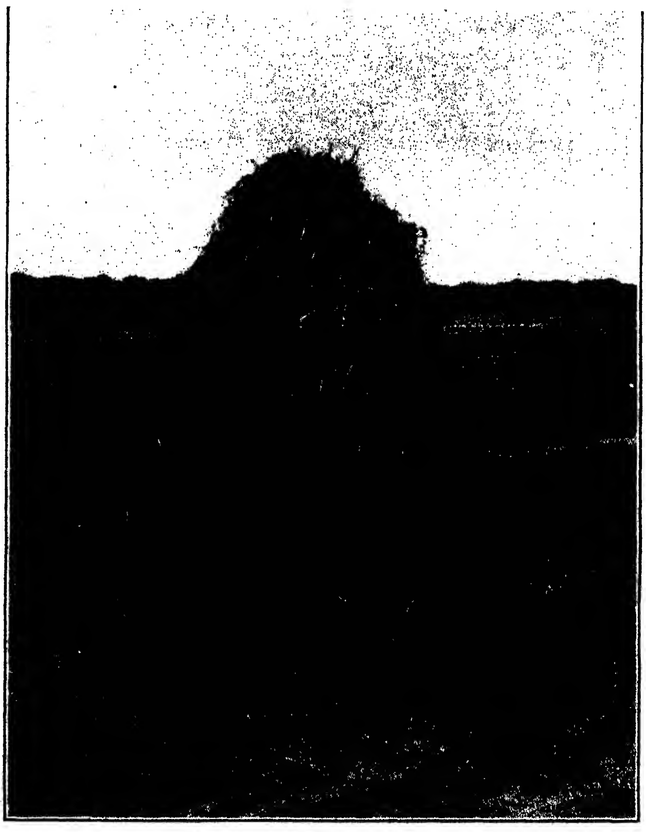

Fig. I.—A Well Made Stack of Beans.

piled about the steel post. The bottom formed by the beans should not be over three or three and one-half feet in diameter. The stack is built up straight for two to two and one-half feet and then bulged a little. From this budge the stack is drawn in slightly until it is capped well above the post. This will give a good sized stack when it settles.

The stacks may be built with vertical sides, using a large well placed cap over the top of the post. Care should be exercised in building a uniform well capped stack. For the average bean crop, about ten of these stacks are necessary per acre. Very little of the land area is thus occupied by the bean stacks.

The steel fence posts are being recommended at present because they are substantial, available at reasonable expense, easily set, and make good posts to build around. They can also be used for a long period of time and still have value.

There are a few precautions which should be emphasized:

1—**Get the beans into these stacks as soon as they are ready in the fall.**

2—Build the bottoms narrow, not over three or three and one-half feet in diameter.

3—Do not have any part of the stack over three and one-half to four feet in diameter.

4—Keep the beans about the bottom of the stack picked up and have the straw protrude beyond the beans.

5—Make straight or very slightly bulging stacks with well made caps.

By getting the beans up early, damage which might result from rains is prevented and the pick is greatly reduced. The beans can

Fig. II.—A 30-acre field of beans stacked around posts for curing. Wheat can be seeded on time when bean fields are harvested and secured early. Taken September 29, 1926.

remain in the stacks until some good day later on in the fall when everything has been cared for and it is convenient to thresh.

The beans should be pulled and stacked the same day if weather is threatening. If fair weather prevails leaving the beans in windrows over night compacts the vines and makes them more easily handled.

The cost estimates on putting up beans by "The McNaughton System" average much alike. The range is from two to five acres per man per day, depending upon the cleanliness of the bean field. The posts cost $3.70 per acre on the average.

Preliminary experiments carried on at the Michigan State College during the fall of 1926 affirm the method. Beans that were stacked late in September, after considerable damage had been done, and threshed the middle of October, picked four pounds less of damaged and stained beans than those pulled and threshed the first of October. These beans should have been poled two weeks earlier for best results but it was shown that the damage was more severe in the beans left standing in the field and threshed the first of October than those that were stacked.

The beans from the stacks threshed out in excellent condition. The moisture content was low. Beans from the stacks, threshed the middle of October, could have been stored in large quantities without any danger of heating. Those threshed the first of October carried more moisture and could not have been stored in quantity.

The stacks offer greater opportunity for the winds to dry the beans. It takes but a short time after a shower for a light breeze to dry the beans sufficiently for threshing. This feature alone aids very materially in the preparation of a bean crop for market.

"The McNaughton System" will:

1—Eliminate most of the hazards of bean harvest at a very low cost.

2—Produce beans with a small pick instead of large pick or a lost crop.

3—Permit fall grains to be seeded earlier and reduce possible losses.

4—Greatly aid the curing of weedy beans with no risk from the weather.

5—Secure the beans until a machine can be obtained for threshing.

6—Get the beans taken care of so that other crops may be harvested at the proper time.

7—Do away with a lot of work and worry.

8—Reduce the pick below that of beans left standing in the field a few days after the other beans are stacked as shown by the preliminary experiments.

NOTES ON SOME OF THE NEWER SPRAY MATERIALS

BY W. C. DUTTON, HORTICULTURAL SECTION

Schedules of application and materials recommended for spraying Michigan Fruits are contained in the "Spraying Calendar," Special Bulletin No. 140 of the Michigan Agricultural Experiment Station, copies of which may be had on request to R. S. Shaw, Director, East Lansing, Michigan. The recommendations contained therein are, all things considered, the safest and best known for average conditions. Many materials are offered to the grower as substitutes for those recommended in the Spraying Calendar. Slight modifications in the schedule of applications or in concentration of the materials or in the materials themselves may be attended by no serious consequences in the form of reduced control of pests or of greater spray injury; they may even be desirable to meet special conditions. On the other hand, such changes should be made with caution and only after obtaining definite information from authentic sources as to the results that may be expected. It is the purpose of this circular to point out the advantages and disadvantages of some of these materials and to indicate the conditions under which they can be used safely.

Dry Lime-Sulphur.—Some manufacturers offer dry lime-sulphur as a substitute for the standard liquid lime-sulphur. This is simply the liquid form which has been reduced to the dry state by the evaporation of the water and to which usually some kind of a "stabilizer" has been added. It has to be dissolved in water before application to trees and should not be confused with sulphur dust. The effectiveness of liquid lime-sulphur depends on the sulphur and the sulphur-containing compounds that it has in solution. The insecticidal and fungicidal value of dry lime-sulphur lies principally, if not entirely, in these same chemical constituents; therefore dry lime-sulphur should be used at a rate that will give an equal amount of these active ingredients in the dissolved material. Dry lime-sulphurs vary somewhat in composition but on the average four pounds of dry lime-sulphur will be required to equal one gallon of liquid concentrate. To determine how much dry lime-sulphur to use for any particular purpose, multiply the recommended number of gallons of the concentrated liquid lime-sulphur by four; this will give the necessary number of pounds of the dry material. The recommendations in the spraying calendar for summer applications on apples, for instance, call for two and one-half gallons of the concentrate to each 100 gallons of diluted spray. The equivalent of this in dry lime-sulphur would be 10 pounds. Instances have been reported where satisfactory results were obtained with eight or six or even fewer pounds of the dry. Under those same conditions probably equally good results could have been obtained with one and one-half or two gallons of liquid in 100. However, unless the grower knows definitely that he can depend on the weaker concentrations he should use the recommended strength. There is no evidence that dry lime-sulphur is any more effective per unit of active ingredients than the liquid. The question of convenience and cost is one for each grower to decide for himself.

Other Sulphur Sprays.—Several other compounds of sulphur are offered for various uses. *B. T. S.*, a compound of barium and sulphur, cannot be recommended at this time as little information is available. *Sulfocide* a compound of sodium and sulphur, is not recommended for general use. Its value for the control of apple scab in Michigan has not been well established and in some experiments its use was followed by much more "blossom end" injury on the fruit than was found on lime-sulphur sprayed trees. When it is used with lead arsenate it is necessary to add casein spreader to retard the formation of water soluble arsenic and the materials have to be mixed in a definite order and even when carefully mixed in this way severe injury on peaches has been observed. *Soluble Sulphur* is another compound of sodium and sulphur that has been on the market for a number of years and that has been sold for dormant season use. It has generally given satisfactory results in the control of scale insects and peach leaf-curl but should not be used for summer applications on any kind of fruit. *Sulphurette* is another similar compound about which little information is available.

Dry-Mix Sulphur-Lime Spray and Wettable Sulphur.—The dry-mix sulphur-lime spray (usually called simply "dry-mix") is a mixture of sulphur, hydrated lime and casein spreader. For use in the orchard it is mixed with water and applied as a spray. It is the standard fungicidal spray for summer applications on peaches and Japanese plums but it cannot be considered the equal of lime-sulphur for the control of apple scab. The advantage in using it on apples lies in the fact that it is not likely to cause foliage injury or russeting of the fruit and it might be substituted to advantage for lime-sulphur after the calyx or petal-fall application, provided scab has been thoroughly controlled by the early sprays of lime-sulphur. *Wettable Sulphur* is simply sulphur to which a small amount of some other material has been added to cause it to mix easily with water. Little definite information concerning this material is available, but its effectiveness is probably about the same as that of "dry-mix." If used with lead arsenate the addition of lime is advisable to reduce foliage injury.

Casein Spreader.—A mixture of finely powdered casein and hydrated lime, known by several names as casein spreader, calcium caseinate and casein-lime, is offered as a spreader and sticker for several sprays. It may be used to advantage in some instances but not in others. It is not a satisfactory substitute for resin fish-oil soap in grape spraying, but may be used to advantage with lime-sulphur in the delayed dormant application on dewberries and raspberries, though it is not absolutely essential. Its general use with lime-sulphur and lead arsenate on apples is not advised. Under some conditions, slightly better control of scab may result, but more foliage injury has followed in some instances and its value in connection with codling moth control has been questioned, although when used with late cover sprays there is less blotching of the fruit with the spraying materials.

Dusting.—The substitution of dusting for spraying has taken place to a certain extent during the last few years and without doubt this change will continue. There is much difference of opinion as to the value of the dusting method and this difference is probably largely due to the manner of use of dusts, and to varietal, regional and seasonal variations in the prevalence of insects and diseases.

There are many self-evident advantages of the dusting method such as lower investment, lower upkeep and depreciation and simpler operation as

well as greater speed of application, which makes it possible to cover an orchard quickly at critical times. Lower labor costs are incident to the more rapid application. Other advantages are that with most dusting materials there is little foliage injury and the fruit usually has excellent finish. This refers especially to sulphur-lead dusts.

Some disadvantages of the dusting method are that there is no material known which can be recommended for all dormant applications. Material costs are almost always greater. It is also frequently more difficult to find conditions favorable for dusting than for spraying. Wind is the most frequent interfering factor, but temperature, humidity and moisture on the plant are at times important. The difficulty of finding favorable conditions is probably compensated for, in part at least, by the greater speed of application but there still remains the question of effectiveness. Some pests, such as those that attack peach foliage and fruit, are readily controlled by dusting. Others, such as apple scab, cherry leaf-spot and codling moth, have been controlled satisfactorily in many seasons but there is still some doubt as to whether dusting, as ordinarily done, will prove satisfactory in seasons when, or in areas where conditions are very favorable for their development and spread. It may be safely said that under severe conditions it is easier to obtain control of these and other troubles by spraying than by dusting, but many growers prefer to take this chance in order to get the benefit of the advantages of the dusting method. This is particularly true with growers who have large acreages where dusting is used entirely, or as a supplement to the spraying to enable the grower to complete an application quickly or to make some emergency treatment when it is not convenient or desirable to spray.

Miscible Oils and Oil Emulsions.—Oil sprays of several kinds are offered for the control of many insects. In the control of San Jose scale oils may be expected to give satisfactory results if properly used but it is frequently desirable to control other insects or a disease with the same application. There seems to be no reason for using an oil spray for peaches under Michigan conditions, as it is necessary to spray regularly for leaf-curl. Lime-sulphur will control scale and leaf-curl; oil will control only the scale.

The standard recommendation for the "delayed-dormant" application on apples, calls for dormant strength lime-sulphur and nicotine sulphate to control scale and aphids. Oils used at this time will control scale but their value in the control of aphids has not been fully determined, although the indications are that they will be effective if used very thoroughly. In orchards where the fruit tree leaf-roller is prevalent it is necessary to use a miscible oil and to those available in Michigan Scalecide seems to be the most effective. The value of oils on pears for the control of psylla is uncertain and definite recommendations for or against its use cannot be made at this time.

Another factor of importance is the effect of the oil spray on the trees, as it is known that fall or early spring applications may cause injury to peaches and pears and injury has occurred on apples in a few instances, however, there is little reason to believe that such injury will follow late dormant or "delayed-dormant" applications in Michigan. The inconvenience and difficulties in connection with the preparation of home-made emulsions and the precautions necessary in storing and diluting them may be serious obstacles to many growers not specially equipped. In general,

the commercial miscible oils are simpler to use but more expensive; the home-made emulsions are much cheaper but involve more care in preparation and use.

Calcium Arsenate.—This material is a satisfactory substitute for lead arsenate on some crops but should not be used on fruit trees in Michigan. It has a higher arsenic content and is cheaper than lead arsenate but is likely to cause foliage injury. This may not develop immediately after application but may be delayed for some time. It is probably brought about by reaction of the carbon dioxide in the air with the calcium arsenate, thus forming some water-soluble arsenic which injures the foliage.

Thoroughness and Timeliness.—The use of the materials recommended in the Spraying Calendar does not insure satisfactory results unless applied in a thorough and timely way and in accordance with the recommended schedule. Many failures to control pests have been traced definitely to these factors. *Thoroughness* consists in covering all susceptible portions of the tree with material, or in the case of contact sprays, of covering every egg, egg mass, or insect with the spray. The best method of procedure necessarily varies with the pest to be controlled. *Timeliness* means, not only that the schedule should be followed, but that each application should be made at the period recommended. A delay in one application is likely to mean that succeeding applications will be equally delayed.

It is desirable to keep the cost of spraying as low as possible, but since the cost of the materials is only a small part of the total cost of producing and harvesting a crop of fruit it is evident that the greatest economies in spraying should come in more efficient application rather than in using cheap or untried substitutes for the standard materials.

The Bulletins of this Station are sent free to all newspapers in the State and to such individuals interested in farming as may request them. Address all applications to the Director, Agricultural Experiment State, East Lansing, Michigan.

LIST OF AVAILABLE BULLETINS

Regular Bulletins—

251 Insects of 1907.
258 Insects of Field Crops.
262 Suggestions on Planting an Orchard.
264 Second Report of Grade Dairy Herd.
267 Michigan Weeds (only to libraries and teachers).
273 Utilization of Muck Lands.
277 Studies in the Cost of Market Milk Production.
281 Trees, Shrubs and Plants for Farm and Home Planting.
284 Some Information and Suggestions Concerning the Use of Phosphorus.
286 Studies and Cost of Milk Production—No. 2.
289 Corn Growing in Michigan.

Special Bulletins—

58 Foul Brood.
65 Hog Cholera and Preventive Treatment.
70 Michigan Agriculture, Its Present Status and Wonderful Possibilities.
71 Studies in the Range and Variation of the Per Cent of Butter Fat in the Milk of Individual Cows.
74 Analysis of Some Materials Sold as Insecticides and Fungicides.
76 Transferring Bees.
79 Michigan's Shifting Sands; Their Control and Better Utilization.
80 Yellow Rocket (a dangerous weed).
82 Durability of Concrete Drain Tile No. 11.
83 Key to Orthoptera of Michigan.
90 Special Report of the Upper Peninsula Experiment Station.
91 Some General Information on Lime and Its Uses and Functions in Soils.
94 The Financial History of a Twelve-Year-Old Peach Orchard.
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99 The Detroit Commission Plan of City Milk Administration.
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106 Sugar Beet Growing in Michigan.
107 Diseases of Bees in Michigan.
108 The Robust Bean.
109 Dependable Michigan Crop Varieties.
110 Special Report of the Upper Peninsula Experiment Station.
111 Studies in City Milk Distribution.

112 An Experiment in Improving the Milk Supply of a City Milk Plant.
116 The Agriculture of the Upper Peninsula of Michigan.
118 Pruning Fruit Trees.
119 The Septic Tank and Sub-Surface Tile Sewage Disposal System.
120 The Microscopic Identification and Determination of the Specific Ingredients in Stock Feeds.
121 Grape Production in Michigan.
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123 Second Growth Hardwood Forests.
124 The Colorimetric Hydrogen-ion Determination as a means of Locating Faulty Methods at City Milk Plants.
125 Michigan Potato Diseases.
126 An Analysis of the Peach Variety Question in Michigan.
127 Nitrogen-Carrying Fertilizer and the Bearing Habits of Mature Apple Trees.
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133 Fertilizers. What they are and how to use them.
134 Greenhouse Insects.
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141 Profitable Pruning of the Concord Grape.
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145 Christmas Tree Plantations.
146 Air-cooled Storage for Apples.
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148 Some Important Grape Insects.
***149 Eighty Winters in Michigan Orchards.**
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***158 A Suggested Bacteriological Standard for Ice Cream.**

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34 More Wheat for Michigan.
37 Raspberry Culture.

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43 Increasing the Production of the Bearing Apple Orchard.
44 The European Corn Borer.
47 Poisoning from Bacillus Botulinus.
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52 The Grape Berry Moth in 1922.
53 Standard Fertilizers for Michigan.
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58 Lime Requirement for Berrien County.
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60 Lime Requirement for Kalamazoo County.
61 Paving for Milk on a Quality Basis as a Means of Improving the Supply.
62 The Simplex Lime Spreader.
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64 Simple Water Systems.
65 Alfalfa and Horses.
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70 The Present Status of the European Corn Borer in Michigan.
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***98 How to Make and Preserve Cider.**
***99 House Plants.**
***100 Michigan Farmers Tax Guide.**

Quarterly Bulletins—

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13 Oat Smut and Its Control.
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40 Pruning Black Raspberries.

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48 Poultry Housing.

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66. The Significance of Bacterium Abortus Antibodies (Agglutinins and Complement-fixing) Found in the Sera of Calves at Birth or After Nursing.
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74 Effect of Nutrient Conditions on Colloidal Properties of Certain Vegetable Crops.
75 Influence of Nutrient Supply on Earliness of Maturity in Cabbage.
76 Concentration of Materials and Rates of Application in the Control of Apple Scab.

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Regular bulletins include all publications reporting investigation work in connection with subjects of general interest and handled in a more or less popular way.

Special bulletins are bulletins of a popular nature, and deal with special lines of work.

Circulars are briefly and concisely written discussions of a popular nature.

Technical bulletins, as the name implies, are devoted to reports of scientific research and designed more especially for use of other investigators, instructors and students.

The Quarterly bulletin contains contributions by all sections of the Experiment Station. It is issued during February, May, August and November of each year. Copies are sent to the entire mailing list. The Quarterly also contains a list of available bulletins.

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Single Copies of bulletins are for free distribution as long as the supply lasts. Quantities of bulletins may be secured at cost.

Requests for bulletins should be limited to those actually needed.

Bulletins are not intended to be used as text books in classes, but upon application, libraries of colleges and public schools of Michigan will be supplied with a few copies for class reference.

Order by classification and number.

All applications for bulletins should be addressed to R. S. SHAW, DIRECTOR, East Lansing, Mich.

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Postoffice and Telegraph address - - - - - - - East Lansing, Mich.
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Loree, R. E., M. S.	Res. Asst. in Hort.
Partridge, N. L., Ph. D.	Res. Asst. in Hort.
Wheeting, L. C., M. S.	Res. Asst. in Soils
Cormany, C. E., M. S.	Res. Asst. in Crops
Duncan, J. R.	Res. Asst. in Crops
Pettigove, H. R., B. S.	Res. Asst. in Crops
Mallman, W. L., M. S.	Res. Asst. in Bact.
Brown, H. M., M. S	Res. Asst. in Crops
Lill, J. G., M. S.	Res. Asst. in Crops
Lavis, C., B. S.	Res. Asst. in Crops
Churchill, B. C., M. S.	Asst. in Crops
Marston, A. R., M. S.	Asst. in Crops
Fogle, F. E., B. S.	Res. Asst. in Agr. Eng.
Sauve, E. C., B. S.	Res. Asst. in Agr. Eng.
Robey, O. E., B. S.	Res. Asst. in Agr. Eng.
Gallagher, H. J., M. Agr.	Res. Asst. in Agr. Eng.
Thaden, John F., M. S.	Res. Asst. in Soc.
Torrey, J. P., M. S.	Res. Asst. in Bact.
Martin, Wilson, B. S.	Asst. in Forestry
Gaston, H. P., B. S.	Asst. in Hort.
Pearson, Peter, B. A.	Statistical Clerk, Soc.
Trull, F. W., B. S.	Asst. in Soils
Weideman, A. G., M. S.	Asst. in Soils
Romaine, J. D., B. S.	Asst. in Soils
Schlubatis, G., M. S.	Asst. in Soils
Musselman, Marion G., B. S.	Asst. in Chem.
Burt, Kenneth, B. S.	Asst. in Chem.
Bandemer, Selma L., M. S.	Asst. in Chem.
Carpenter, Miriam C., M. S.	Asst. in Bot.
Clements, H. F., M. S.	Asst. in Botany
Johnson, E. P., D. V. M.	Asst. in Bact.
Sholl, L. B., B. S., D. V. M.	Asst. in Animal Pathology
Putnam, G. W., M. S.	Director Upper Peninsula Experiment Station, Chatham
Wells, H. M., B. S.	Supt. Graham Horticultural Experiment Station, Grand Rapids.
Johnston, S., B. S.	Supt. South Haven Horticultural Experiment Station, South Haven
Landon, L.	Librarian
Schepers, J.	Cashier
Campbell, M. W.	Bookkeeper
Bogue, M. V.	Bulletin Clerk

SUB-STATIONS

Chatham, Alger County, 780 acres deeded. G. W. Putnam, Director.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded. S. Johnston, Supt.
Graham Station, Kent Co., 50 acres donated by R. D. Graham; 50 acres purchased. H. M. Wells, Supt.
Dunbar, Chippewa County, Forestry station, 577 acres deeded.
Monroe, Monroe County, Corn Borer Station, 7½ acres rented.


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R. S. SHAW AND E. B. HILL

CONTRIBUTIONS BY ALL SECTIONS OF THE
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MICHIGAN AGRICULTURAL EXPERIMENT STATION QUARTERLY BULLETIN

Vol. 9, No. 4, May, 1927

RESULTS OF POTATO SPRAYING AND DUSTING EXPERIMENTS 1926

Studies Made in State Demonstrate Increase in Yield Follows Application of Dust or Spray

H. C. MOORE, FARM CROPS SECTION

An experiment was conducted at the Michigan State College to compare the effectiveness of dust and liquid spray in controlling insects and fungous diseases attacking the foliage of potatoes.

Three plots (one-ninth acre each) received five applications of a copper-lime dust analyzing twenty-five per cent dehydrated copper sulphate and seventy-five per cent hydrated lime. The dust was applied with a horse drawn duster equipped with an engine. Four rows were dusted at a time with two nozzles for each row. Approximately thirty pounds of dust were applied per acre at each application.

Three plots (one-ninth acre each) were sprayed five times with bordeaux mixture (4-4-50). A traction type sprayer having three nozzles per row and maintaining two hundred pounds pressure was used. Approximately one hundred gallons of bordeaux mixture were put on at each application.

Dust and spray applications were made on the following dates: July 22, August 3, August 13, August 24, and September 9.

Four plots (one-ninth acre each) were left as checks and received no dust or spray.

Certified seed of the Russet Rural variety was used for planting the test plots.

Summary of Field Notes

Records were made of the plots on August 18 and September 17. Early blight and leaf hoppers were the only troubles of any consequence during the season.

Plants in both the sprayed and dusted plots showed vigorous growth with dark green leaves and very slight injury from leaf hoppers and early blight.

Plants in the check plots showed some dying of the lower leaves by August 18, and considerable rolling of the leaves with purplish discoloration at the tips and margins. By September 17th, plants in the check plots had yellowish green foliage with serious rolling of the

leaves from leaf hopper injury. It was estimated that 50 to 75 per cent of the foliage was injured by leaf hoppers and early blight.

Counts were made on the number of leaf hoppers on six plants from each of the three treatments (Spray-Dust-Check).

The results are given in the following table:

Treatment	Average number of leaf hoppers per plant August 17	Average number of leaf hoppers per plant September 17
Bordeaux mixture spray	5.7	5.8
Copper lime dust	8.1	9.4
Check	41.0	89.8

The test showed that both the bordeaux spray and the copper lime dust were effective in repelling leaf hoppers throughout the season, there being practically no increase of this insect in the sprayed and dusted plots. In the check plots the leaf hoppers increased over 100 per cent between August 17 and September 17.

Records of Yield

The vines were killed by frost September 26 and the plots were harvested October 18.

A summary of the records of yield are given in the following table:

Treatment	Average yield per acre U. S. No. 1 bushels	Total yield per acre bushels
Bordeaux mixture spray	169.3	188.4
Copper-lime dust	159.4	177.5
Check	99.8	127.5

The bordeaux mixture spray gave an increased yield per acre of 69.4 bushels of U. S. No. 1 over the check plots.

The copper lime dust gave an increased yield per acre of 59.5 bushels of U. S. No. 1 over the check plots.

Comparative Costs of Spraying and Dusting

In the spraying-dusting experiment conducted in Oakland county records were kept on cost of materials and labor. Spray and dust materials used were the same as those used in the Michigan State College experiment. The dust was applied with a four row traction duster and the spray with a high pressure (200 pounds) traction sprayer.

The spray and dust plots were each three acres in size. The check plot was 5/16 of an acre. The spray and dust applications were made on the following dates: August 6, August 17, August 30, September 10. The amount of dust used for each application was 33 pounds. The amount of bordeaux mixture for each application was 100 gallons.

The following table gives a summary of the costs per acre:

Cost of dust materials per acre 4 applications	$8.98
Cost of man and horse labor per acre for dusting. 4 applications	1.78
Total cost per acre for dusting:	$10.76
Cost of spray materials per acre 4 applications	$3.06
Cost of man and horse labor per acre. 4 applications	4.00
Total cost per acre for spraying:	$7.06

For man and horse labor there was a saving of $2.23 per acre in favor of the dusting.

For materials there was a saving of $5.93 per acre in favor of the spraying.

Yield Records

The plots were harvested October 12th. Yields are recorded in the following table:

Treatment	Total yield per acre
Bordeaux mixture spray	263 bushels
Copper-lime dust	252 bushels
Check	238.9 bushels

Increased yield of sprayed plot over check 10.09 per cent.
Increased yield of dusted plot over check 5.48 per cent.

A COMPARISON OF SOIL MANAGEMENT METHODS IN A YOUNG APPLE ORCHARD

Investigation Shows Some Cultural Practices More Expensive Than Results Warrant

BY H. D. HOOTMAN AND H. M. WELLS, HORTICULTURAL SECTION

Fruit growers for many years have been interested in the relative merits of the sod-mulch and clean-culture methods of orchard soil management. Some data on comparative costs and on the influence of the two practices are furnished by an experiment that was started at the Graham Horticultural Station, near Grand Rapids, in 1919. Trees of Duchess, Grimes, Baldwin, Stayman, Northern Spy, and Rhode Island Greening were set 20 feet apart each way in a clay loam soil that is

typical of much of the heavier orchard land in central and eastern Michigan. Corn was raised between the tree rows the year that the orchard was set. At the time of the last cultivation, about the middle of July, a cover crop of rye was sown. The trees made a short but satisfactory growth the first year.

In the spring of 1920 the orchard was divided into five plots, which received different soil treatments, as follows:

Plot 1.—Clean Cultivation with a cover crop;

Plot 2.—Clover-Straw mulch. All hay removed from the plot. Straw applied as a mulch around the trees;

Plot 3.—Alfalfa-Straw mulch. All hay removed from the plot. Straw applied as a mulch around the trees;

Plot 4.—Alfalfa-Alfalfa mulch. One cutting removed from the plot, the balance used as mulch around trees;

Plot 5.—Alfalfa-Alfalfa mulch-fertilizer. Same as Plot 4, with an application of nitrate of soda each spring.

All trees in plots where a mulch was used were protected from rodent injury by tree guards.

The cost of maintaining each plot was carefuly kept and the influence of the various cultural practices on the growth and earliness of bearing recorded. Labor costs were calculated at $0.30 per hour for man labor and $0.60 per hour for man and team. The hay crops of clover and alfalfa removed from Plots 2, 3, 4, and 5 were valued at $12.00 a ton.

Plot 1 was plowed each spring, dragged every week or ten days until the middle of July or first of August, and then sown to a cover crop of oats, rye, or rye and vetch. The cost of maintaining the plot under this tillage, cover crop system, has averaged $10.58 per acre per year during the seven-year period. This cost does not take into account land rental, supervision, spraying, pruning, or harvesting costs. It includes simply the cost of soil maintenance.

Plot 2 was seeded to clover in 1920 but the catch was poor. It was reseeded on a late snow the following spring and a good stand secured. However, there was not a sufficient growth that year to justify cutting it for hay. A heavy mulch of straw was applied around each tree in a circle six to eight feet in diameter and about six inches deep. This heavy mulch of straw has been maintained by new applications whenever necessary. In 1922, 1923 ,and 1924 the clover produced on this plot was removed as a hay crop. Since 1924, the clover has been largely supplanted by blue grass, which has been mowed once each year and allowed to lay in the swath. The cost of maintaining the plot under this clover-straw mulch system, after deducting the value of the clover hay removed from the plot, has averaged $8.86 per acre per year, during the seven-year period. This has been due largely to the high price that it was necessary to pay for the straw. During the two years when no straw was added to the mulch the cost of maintaining the plot was less than a dollar an acre annually.

Plot 3 received the same treatment as Plot 2, except that alfalfa was seeded between the tree rows instead of clover. All of the alfalfa was removed from the plot and used as hay. The alfalfa has withstood the crowding out by June grass much better than did the clover.

Creditable cuttings of alfalfa were still being made at the time this account was written. The value of the alfalfa hay removed from the plot has resulted in an average net profit each year of $5.94 per acre.

Plot 4 was seeded to alfalfa, the same as was plot 3. One cutting each year has been removed from the plot for hay; the balance has been used as a mulch around the trees. The cost of maintenance under this system of management has been considerably less than where straw was hauled on the plot for mulching purposes. This plot has yielded an average net profit each year of $6.80.

Experience has shown that the most convenient way of handling alfalfa in an orchard, where one cutting is to be removed as a hay crop, is to remove the first cutting. When three cuttings are made, the second is cut close to the ground and allowed to lay in the swath. After the third cutting the two are raked together and placed around the trees. By the following spring the material has rotted down sufficiently to make a fair mulch at the time the trees require the greatest amount of moisture. By handling alfalfa in the orchard this way the mulch does not interfere materially with the mowing of the first cutting in the spring.

Plot 5 received the same treatment as Plot 4 and in addition an application of nitrate of soda on the mulch under the spread of the branches. This was applied each spring about the middle of April. In 1920 one-quarter pound was used around each tree. This amount was steadily increased until 1926 when five pounds were applied per tree. The cost of the fertilizer was such that the maintenance cost of this plot just about equalled the income from the alfalfa hay that was obtained during the seven-year period.

Soil maintenance costs for all the plots are summarized and averaged in the accompanying table.

Table 1.—Average net soil maintenance costs or profits per acre per year, average yields and average trunk circumferences for the different systems of soil management.

Plot	1	2	3	4	5
Treatment	Clean culture—cover crop	Clover—Straw mulch	Alfalfa—Straw mulch	Alfalfa—Alfalfa mulch	Alfalfa—Alfalfa mulch—Nitrate of soda
Average net cost or profit per acre per year..........	—$10.58	—$8 86	$5 94	$6 80	$0 00
Average total yield per tree first seven years, in pounds.	53	30	42	47	43
Average trunk circumference all varieties, in inches....	12.9	12.8	11.2	11.1	10.6

Influence of Treatments on Tree Growth

The question of first importance to the fruit grower is not the cost of the different treatments, but their effect on the trees. In general it may be stated that the trees in all the plots have done well. The largest trees are in the clean culture-cover crop plot. They have the largest trunk circumference and also the largest height. Those in the

clover-straw mulch plot rank second in size, followed by the trees in the alfalfa-straw mulch plot. The trees in the alfalfa-straw mulch plot are noticeably larger than the trees in plots 4 and 5 that were mulched only with the alfalfa that grew on the plot after the first cutting was removed each year. Contrary to what would be expected the trees in plot 5, where nitrate of soda was applied, are not quite so large as those in the alfalfa-alfalfa mulch plot, possibly suggesting that moisture rather than nitrates has been the limiting factor for growth. However, the alfalfa each year has shown a quick response to the applications of nitrate in the form of increased growth and a darker green color.

There has been a marked difference in the color of the foliage on the trees in the different plots. Those in the clean culture-cover crop

The slight increase in size of the trees on the left, in the cultivated area, was obtained at a cost of $120 an acre more than the cost for the trees in sod on the right.

plot have always had dark green leaves. The clover-straw mulch plot has often been noticeable because of a slightly yellowish cast possessed by its leaves. The foliage in the alfalfa plots has been of good color but not so dense as where tillage was practiced.

The Grimes Golden trees have produced the most apples, followed by Stayman, Duchess, Baldwin, and Rhode Island Greening. Northern Spy produced its first fruit in 1926, when a few scattering apples were borne on several trees in the straw-mulch plots. The clean culture-cover crop treatment showed the least tendency to bring the trees into early bearing; however, at the end of the seven-year period the trees in this plot had produced the most apples. The fruit from this plot was the largest in size but had the poorest finish. The clover-straw mulch plot had produced apples of excellent finish, but they have been smaller in size than the apples from any other plots. The fruit produced in the alfalfa plots attained good commercial size for the va-

rieties in question. The yield has not been quite as heavy as in the clean culture plot but better finished apples have been produced.

In brief, the difference between the trees of the several plots at the end of the seven-year period are distinct but rather small. Any close observer would say that the trees in the clean culture-cover crop block are the largest and best for their age. However, it has required an investment of $120.00 per acre more to grow them than it has to grow those in the alfalfa-alfalfa mulch plot and it is doubtful if any good judge of trees would consider them worth one quarter of that much more. The experiment shows that in a fertile clay loam soil, such as the one in which these were planted, it is possible to put an orchard under a sod mulch system of management almost from the start and to grow strong vigorous trees that will compare favorably with the best that can be grown under a clean culture system of management. Furthermore, by so doing it is possible to affect a material saving in the amount that it is necessary to have invested in the orchard at bearing age.

HOLLOW HEART OF POTATOES

Fertilizers and Spacing of Potatoes Affect Percentage of Hollow Potatoes in Crop. A Report of Experiments Conducted in 1926

H. C. MOORE, FARM CROPS SECTION

One series of experiments was located at the Michigan State College where an effort was made to determine the comparative effects of nitrogen, phosphoric acid, and potash used separately and also in various combinations in causing the development of hollow heart.

Certified Russet Rural potatoes were planted on a sandy loam soil that was summer fallowed in the season of 1925. No stable manure was applied. The fertilizer applications were at the rate of one thousand pounds per acre and were based on a fertilizer analyzing three per cent nitrogen, twelve per cent phosphoric acid, and four per cent potash.

The fertilizer was applied broadcast and was worked into the soil immediately after the potatoes were planted. Each fertilizer plot was 1/22 of an acre in size and was replicated three times.

All plots were harvested October 6 to 19 and records of yields and per cent of hollow heart were made.

The following table gives the results secured from the various fertilizer treatments:

Plot No.	Fertiliser treatment	Average yield per acre U. S. No. 1 bushels	Average total yield per acre bushels	Average per cent hollow heart by weight
1..........	Check no fertiliser..........	99.55	125.34	7.29
2..........	*Nitrogen..........	119.90	127.87	7.83
3..........	*Phosphorous..........	136.86	159.94	6.67
4..........	*Potash..........	147.23	161.70	15.27
5..........	Nitrogen plus phosphorous..........	127.39	148.65	2.78
6..........	Nitrogen plus potash..........	148.65	167.70	10.72
7..........	Phosphorous plus potash..........	161.66	179.06	7.97
8..........	Nitrogen plus phosphorous plus potash..........	178.87	200.37	5.59

*Nitrogen (nitrate of soda, 167 lbs. per acre).
*Phosphorous (16% acid phosphate, 750 lbs. per acre).
*Potash (muriate of potash, 77 lbs. per acre).

Potash applied alone delayed the maturity of the vines and produced the greatest amount of hollow heart. The lowest percentage of hollow heart was in the plots treated with nitrogen and phosphorous combined.

Plot 8 treated with the complete fertilizer (3-12-4) outyielded the check plot by approximately 75 bushels per acre, and produced a somewhat smaller per cent of hollow potatoes.

.Forty pounds of U. S. No. 1 grade potatoes from each plot were examined for desirable market qualifications such as trueness to type, smoothness, and other factors.

59.5 per cent of the potatoes in the check plot were of good market type. Potatoes from each of the fertilizer plots averaged somewhat better than those from the check plots in the percentage of good type tubers.

The best quality potatoes were found in plot 7, which was treated with a combination of phosphorous and potash; the percentage of good type potatoes being 73.85. In plot 8, which was treated with the complete fertilizer, the per cent of good type potatoes was 67.0.

When Does Hollow Heart Develop

An examination of tubers from 46 individual hills August 20, did not show any hollow heart. The average weight of tubers per hill was 3.6 ounces.

The first hollow potatoes were observed August 30, 82 days after planting. Fifty-four hills showed an average weight of tubers per hill of 8.52 ounces and 3.56 per cent of hollow heart.

September 13 to 18, 1,130 hills were dug; the average weight per hill was 14.18 ounces and 5.78 per cent of the tubers were hollow.

A killing frost occurred September 26. 1122 hills dug between September 30 and October 4 showed 10.86 per cent of the tubers hollow, while the average weight per hill was 19.82 ounces.

The amount of hollow heart increased nearly 100 per cent during the last ten days or so of the growing season. It is believed that the heavy rainfall in September (1.09 inches above normal) promoted excessive development of hollow heart.

In this test no hollow heart was found in tubers weighing less than two ounces.

Relation Between Number of Stalks Per Hill and Per Cent of Hollow Heart

In this test, 263 hills were dug. Seventy-three or 27.7 per cent of the total number dug had one stalk per hill, the average per cent of hollow heart per hill was 22.51. 117 hills or 44.5 per cent of the total number had two stalks per hill, the average per cent of hollow heart was 12.25. Fifty-seven hills, which had three stalks, showed 7.75 per cent of hollow heart, and 16 four-stalk hills 5.96 per cent of hollow heart.

An increase in the number of stalks per hill decreased the percentage of hollow heart and increased the number and total weight of tubers per hill.

Close Spacing of Hills Reduces Hollow Heart

An experiment conducted in Oceana county where 32x16 inch spacing was compared with 32x32 inch spacing gave the following results:

32x16 inch—2 per cent hollow heart; Yield per acre 306.2 bushels.
32x32 inch—13.7 per cent hollow heart; Yield per acre 289.9 bushels.

Similar results were secured in Antrim county where 34x17 inch spacing was compared with 34x34 inch spacing.

34x17 inch—7.84 per cent hollow heart; Yield per acre 384.5 bushels.
34x34 inch—30.90 per cent hollow heart; Yield per acre 351.2 bushels.

COOLING MILK

Fluid Milk Market Requires Adequate Cooling of Milk for Quality Product

E. C. SCOTT, DAIRY HUSBANDRY SECTION

The encroachment of the market milk industry upon the other market outlets for milk in southern and central Michigan is placing the milk cooling problem before the farmers of those sections more forcibly than ever. This phase of milk handling can no longer be slighted. If milk is to be sold for market milk purposes, it is not only essential that it be sweet when it leaves the farm, but it must be of such quality that it will withstand processing and be in a sweet, fresh condition when placed in the hands of the consumer twenty-four hours later. Consequently, immediate and adequate cooling are essential.

Milk cooling equipment has not been neglected in the rapid improvement of farm equipment. Coolers are now on the market which quickly and satisfactorily reduce the temperature of milk to a very low level. It is not only cooled quickly, with the consequent increase in quality of the product, but it can be done with a minimum of labor expended.

The drudgery associated with the cooling of milk under the old method, which required a long period of stirring, has been entirely eliminated.

Coolers of the new type are all made on the same general principle, in that the milk is run over the surface in a thin layer. Such coolers consist of a metal device containing cold water, preferably running water, over which the milk runs in a thin film. Thus, in cooling, the milk takes advantage of the cooling produced by evaporation as well as the low temperature of the water. An opportunity is also provided to dispose of its volatile odors.

Surface coolers are made in four different styles. The conical cooler with straight sides is probably the oldest style of surface cooler. The drum inside the cooler may be filled with ice water, which must be kept constantly agitated during cooling, or it may be fitted up with running water. The conical shaped spirally corrugated cooler is another type. It is built on the same principle as the straight sided conical cooler except that the surface is spiral in shape. This gives the milk a greater surface exposure and consequently a better opportunity to be thoroughly cooled.

The third type of cooler is the tubular cooler. A series of metal tubes are arranged, one above the other, and are fastened into each other at the ends in such a manner that one long continuous tube is formed. The cold water enters the bottom tube and leaves through the top tube. Thus, the milk running down over the cooler comes in contact first with the warm water, and last, with the cold water just as it enters the cooler. This construction prevents intermixing of the warm and cold water within the cooler. The pipes, which lay one upon the other, are surfaced with a continuous sheet of tin, shaped to utilize the most surface possible, so that the milk runs freely down over the sides.

The fourth type of cooler is the corrugated cooler. It is similar in appearance to the tubular cooler. It is constructed from corrugated metal which is hollow in the center to provide a place for the cooling medium. The water enters at the bottom and leaves at the top, but it spreads out in a sheet inside the cooler, so that there is remixing of the cold and warm water. The last two types of coolers require running water, while the first two types may be employed by filling them with ice water.

The efficiency of the different coolers depends upon the type and temperature of cooling medium employed. If running water of low temperature is available, either the tubular or the corrugated cooler will probably be most satisfactory. In case ice water or cold water is to be used in the absence of running water, the conical straight side or conical corrugated type will probably be most satisfactory. The tubular cooler has the advantage over the upright corrugated type in that the mixing of the cold with the warm water is prevented, while with the conical coolers, the spiral corrugated cooler has the greatest surface exposure, thereby facilitating cooling. However, any surface cooler is quite efficient when properly handled.

In operating the surface cooler, ice water or cold running water is indispensable. When running water is used, 10 to 15 gallons is ample to bring the temperature of one gallon of milk down to within 2 or 3 degrees of the initial temperature of the running water. The amount

of ice necessary to cool the milk when used in the conical cooler depends upon the initial temperature of the water, the speed at which the milk is cooled, and the temperature to which it is to be cooled. Under ordinary conditions, one pound of ice should be sufficient to cool a gallon of milk to the temperature of the original water.

In order to determine how much time is saved by the surface cooler as compared with stirring the milk in cans, and also to determine the temperatures possible to attain by the two methods in an hour's time, a simple experiment was conducted at this station. Seventy pounds of milk was placed in each of seven 10-gallon cans.

The milk in each can was tempered to 95° F., which is the approximate temperature at which it comes from the cow, and the seven cans of milk were cooled as follows:

Can No. 1, Set in water at 53°F., without stirring;
Can No. 2, Set in water at 53°F., stirred every 5 min.;
Can No. 3, Set in water at 53°F., stirred every 10 min.;
Can No. 4, Set in water at 53°F., stirred every 15 min.;
Can No. 5, Set in water at 53°F., stirred continuously;
Can No. 6, Run over conical cooler filled with running water at 53°F.
Can No. 7, Run over tubular cooler fitted up with running water at 53°F.

The tanks in which the cans of milk were placed held approximately three gallons of water per gallon of milk cooled. Enough crushed ice was added to maintain a steady temperature throughout the experiment.

An ordinary milk plant stirring rod was used to furnish agitation. In those cans which were stirred intermittently, the rod was given an upward and downward movement six times throughout the column of milk at each stirring.

The experiment was run in duplicate. Temperature observations were made from the center of each can at five minute intervals. The results of the experiment are presented in the following table:

Temperature of milk at 5 minute intervals

Minutes after cooling began	Number of sample						
	1	2	3	4	5	6	7
5	93.0°F	84.5°F	87.0°F	90.8°F	83 7°F	66.0°F	56.0°F
10	91.5	80.0	82.0	86.5	77.5	....	....
15	90.5	74.0	76.0	82.0	70.0	....	....
20	90.0	71.0	73.0	78.8	68.0	....	....
25	89.2	69.0	71.0	76 4	63.0	....	....
30	88.3	67.0	69.0	74.0	62.0	....	....
35	87.7	65.0	67.2	73.0	61.5	....	....
40	87.0	64.0	65.5	72.8	59.5	....	....
45	86.4	62.0	64.0	72.0	58.0	....	....
50	84.2	61.0	63.0	70.4	57.0	....	....
55	82.7	60.0	62.0	68.5	56.0	....	....
60	80.5	60.0	61.0	66.0	55.0	....	....

The results indicate that surface cooling is far superior to tank cooling. In each instance when the milk was surface cooled, it was reduced to a lower temperature in five minutes (the approximate time taken to pour seventy pounds of milk over the cooler) than when the milk was stirred continuously in the tank for twenty minutes. Surface cooling showed a still greater superiority over intermittant cooling.

Among those samples which were stirred in the tank, the oftener the samples were stirred, the quicker they cooled. Tank cooling without stirring proved to be extremely inefficient.

The tubular cooler showed greater cooling efficiency than did the straight sided conical cooler. However, had the flow of milk over the Conical Cooler been reduced somewhat, a considerable lower temperature could no doubt have been attained.

The speed with which the temperature was reduced by both surface coolers shows emphatically that time and effort can be saved by their use. Since quick cooling is conducive to high quality in milk, and time is valuable to the farmer, there are very few dairymen who can not well afford to investigate the advantages they offer.

THE BACTERIOLOGICAL BACKGROUND OF BUTTERMAKING

IV. Lactic Cultures or Starters*

Making Butter of Uniform Quality Requires Use of Standard Starter

E. D. DEVEREUX, BACTERIOLOGICAL SECTION

Butter is one of the oldest as well as one of the most universal articles of diet. It may be roughly defined as the clean, non rancid product made by gathering in any manner the fat of fresh or ripened milk or cream into a mass which also contains a small portion of the other milk constituents.

Most markets require butter that has been made from sour or ripened cream. A sweet cream butter is usually considered flat and lacking in flavor. Before the day of the controlled starter for the ripening process, cream was kept in a warm place and allowed to sour when chance inoculation occurred. The souring is the result of bacterial action and, if it is not controlled, different kinds of bacteria will cause the souring in successive batches of cream. As a result, the same flavor and aroma can not be expected from one churning to the next.

Today, most creameries pasteurize the cream within a few hours after it is received in order to check further souring. The heating kills a large percentage of the bacteria responsible for the souring.

*This is the fourth of a series of articles on "The Bacteriological Background of Buttermaking." The first three were prepared by G. L. A. Ruehle who was formerly on the staff of this department.

They then add their own starter to the cream to ripen or finish ripening it. In this manner, the desired flavor and aroma are assured each time by the addition of a known controlled starter.

This starter is a material containing desirable bacteria for the cream ripening process. One does not have to examine the literature very long until it is found that more than one organism is given the credit for the production of these desirable properties in butter. Esten and Mason (Storrs Agr. Exp. Sta., Storrs, Conn. Bulletin 83) examined six commercial starters and found a lactic acid producer, *Bacterium lactis acidi* (Streptococcus lactis) to be the predominating organism. While working along the same line, Hammer and Baker (Iowa Agr. Exp. Sta. Research Bulletin No. 81) repeatedly isolated two species from culture starters, Streptococcus citrovorus and Streptococcus paracitrovorus. The latter organism especially was responsible for high volatile acidity. Reid (Milk Plant Monthly 16 (1927) 25-28) was also of the opinion that two types of bacteria were present; non-volatile acid producers or lactic acid producers, and volatile acid producers (largely acetic acid). The volatile acids are set free, in the presence of the non-volatile acids, and are of direct importance in the production of flavor and aroma. The non-volatile acids are thought to make the cream more churnable, that is, the butter will gather earlier. Due to the properties of the three organisms mentioned above it would seem desirable to incorporate all of them in a starter.

Lactic cultures or starters can be purchased in either powder, tablet, capsule, or liquid form. The tablets are very small while the liquid cultures often weigh as much as several ounces. When carefully handled the starter can be carried from day to day for several years. However, with ordinary methods of handling they often gradually become weakened and inefficient. Methods of cultivation have been suggested which will maintain the high activity of the culture.

In the preparation of the "mother starter" from the commercial starter a quart bottle about two-thirds full of milk is sterilized in steam for 20 to 25 minutes at 15 pounds steam pressure. After the milk has cooled, the culture is added, mixed with the milk, and incubated at 60° to 85° F. Sherwood and Hammer (Iowa Agr. Exp. Sta. Res. Bulletin No. 85) found that cultures developed at a certain constant temperature were more satisfactory than those developed at a variable temperature. After 18 to 24 hours the mother starter is ready. However, the above mentioned authors found that rapid coagulations (6 to 8 hours) gave the better starters. The curd should be smooth, without gas holes, and practically free from whey. The starter proper is now prepared by adding one quarter of this mother starter to 40 quarts of milk which has been pasteurized at 150° to 185° F. for 30 minutes. This is then incubated as before, after which it is ready for use with the cream in the proportion of from 5 to 20 per cent. The apparatus for handling the starters can be very simple, as stated by one writer; the more simple the less danger of inviting trouble.

The use of starters of proper quality in the manufacture of butter is recommended, poor starters often do more harm than good. Anyone having difficulty in propogating starters or maintaining desirable starters should feel free to consult the laboratory from which this article is published.

POISON BAITS FOR GRASSHOPPERS AND CUT-WORMS

These Insects Controlled By Baits Properly Prepared and Distributed

R. H. PETTIT, ENTOMOLOGICAL SECTION

So general has the use of poisoned baits become in the warfare against cut-worms and grasshoppers, and so many formulae are in common use that when the term poisoned bran or poisoned bran bait is used, one always feels doubtful as to just what is meant.

Baits for grasshoppers should include salt, while baits intended for use in killing cut-worms are not improved by the use of salt. Bait intended for grasshoppers should be broadcast in finely divided condition during the heat of the day, while freshly made bait similarly applied at dusk is more effective when used for cut-worms.

Bran is the filler or carrier used in all baits considered in this paper. The bran is sweetened and, if intended for grasshoppers, it is salted. It is poisoned in all cases and there is usually a distinct gain noted when fresh fruit-juice is added or, better still, when a small amount of material whose odor suggests fresh fruit, such as banana oil, is used.

During the world war, a shortage of bran increased its price so that saw-dust was used as a substitute and it was found that, when the scarcity or high price of bran makes its use inadvisable, one can substitute fresh hard-wood saw-dust and expect fair results; but bran is always to be preferred when easily obtainable.

Molasses serves pretty well as a sweetening agent. There remains then little choice in the selection of the materials used except in the matter of the poison.

The Poison

Practically all of the poisoned bran bait used in Michigan owes its killing power to some form of arsenical. Two types of arsenical are used. In one type the poison is used in the form of a fine powder and is not soluble in water; that is, it will not dissolve in water but must be mixed with the bran in such a way as to supply each tiny piece of bran with its particle of poison. In order to get a sufficiently even mixture of a powdered insoluble poison and bran, one must continue to stir the two together longer than most people consider necessary or desirable; and, as a consequence, these baits often fail just because they were not sufficiently mixed. The insoluble forms of arsenicals are much easier to obtain and should cost less and, if sufficiently stirred into the bran, they do fairly well. On the other hand, a soluble arsenical can be dissolved in water and when mixed with the molasses and salt, if salt is to be used, all of the ingredients will dissolve simultaneously. When this liquid which contains all of the materials except the scent is stirred into bran, the mixture is bound to be uniform,

since each particle of bran that is moistened is sure to be poisoned. Soluble arsenicals therefore possess an advantage over insoluble forms.

Types of Arsenicals

Among the soluble forms of arsenicals are:

Arsenite of soda (formerly used to kill barberry bushes). Sold dissolved in water in gallon cans.

Arsenate of soda. Sold in crystalline form and readily dissolved in water.

Arsenite of soda. (Home-made, by combining white arsenic and caustic soda.)

The difficultly soluble and insoluble forms include:

White arsenic. (Arsenic acid, and arsenious acid, common sources of arsenic in the manufacture of spraying arsenicals.)

Paris-green. (Arsenite of copper. not quite so satisfactory since it is not so finely ground.)

Bait Made With Liquid Arsenite of Soda or With Crystalline Arsenate of Soda

In the preparation of bait in which one of these poisons is to be used, stir one-half gallon of cheap molasses into about five gallons of water. Add one scant pound of salt if the bait is intended for grasshoppers. Then stir into this mixture one pint of the arsenite of soda solution, which is the type purchased already prepared for use on barberry, or one pound of the arsenate of soda crystals; and then, after allowing all soluble ingredients to dissolve, pour this into one bushel of bran, and stir until all the bran is evenly moistened. When the stirring is nearly completed, add two or three ounces of banana oil. If the bait is intended for killing grasshoppers, too much salt is to be avoided; since, if the mash is too salty, the grasshoppers get all the salt that they want before they have eaten a fair dose of poison.

Home-Made Arsenite of Soda for Grasshoppers

The following formula may be used to make a very cheap and effective grasshopper bait which is recommended by Dr. C. P. Gillette, State Entomologist of Colorado and described in Bulletin 280, (1923) by C. L. Corkins of the Colorado Agricultural College. The dosage is varied slightly from the original as recommended in the bulletin, owing to the higher efficiency of an increased dose of poison as demonstrated by experience in Colorado.

Sodium arsenite, containing eight pounds of white arsenic per gallon, is made according to the following formula:

Formula for Preparing Home-Made Sodium Arsenite

Water (68 pounds)	8½ gallons
Caustic Soda or Lye	32 pounds
White Arsenic	100 pounds

Use a tub or barrel that will have a capacity of at least 15 gallons. Measure 8½ gallons of water and pour into the barrel. Dissolve in the water 32 pounds of caustic soda or lye (the ordinary household grade of lye obtained in grocery stores is satisfactory for this purpose). When the lye dissolves, it will be noticed that the water becomes warm. After all the lye is dissolved, stir in the powdered white arsenic a little at a time as fast as it is dissolved until the 100 pounds of arsenic has been added. The addition of the arsenic generates more heat and no external heat is required. This will make about 12½ gallons of a thick syrupy liquid containing eight pounds of arsenic per gallon. It is important to constantly stir the solution while the arsenic is being added.

Home-Made Sodium Arsenite Bait*

In preparing the bait for use in killing grasshoppers, stir together thoroughly. If the bait is to be used against cut-worms, omit the salt.

100 pounds bran
1 quart of the Home-made arsenite of soda, described above
5 pounds of common salt
3 ounces banana oil
2 gallons cheap molasses
About 10 gallons of water

White Arsenic Bait for Cut-Worms and Grasshoppers

Mix very thoroughly

1 bushel of bran
½ gallon of cheap molasses
A little water
1 pound white arsenic, (not arsenate of lead or arsenate of calcium) or
1 pound Paris green.

When thoroughly mixed, stir in enough amyl acetate (banana oil) to slightly scent the mass, about two or three ounces at most.

If the bait is intended for use against grasshoppers, add also one scant pound of common salt.

All of these baits are applied by broadcasting so that they break up finely and remain on the surface of the soil. If allowed to spread in lumps, the bait may attract wild birds and poultry.

WARNING

It is to be remembered that none of the arsenicals thus far mentioned, for use in baits, are safe to use in the form of sprays or dusts for controlling insects on vegetation with the exception of paris-green, since all of them except paris-green would be certain to kill such plants as

*Since this article was written, experiments have shown that the Home-made Arsenite bait, which was originally intended for grasshoppers only, is equally effective against cutworms if the salt is omitted.

were treated. It will not be out of place, here, to state as well, that **neither arsenate of lead nor arsenate of calcium will prove efficient when used in baits for the purposes just mentioned.**

BOVINE INFECTIOUS ABORTION (BANG'S ABORTION DISEASE)

Methods of Determination of Disease and Methods of Taking Blood Samples

I. FOREST HUDDLESON, BACTERIOLOGICAL SECTION

Bovine infectious abortion is a disease which needs no introduction to those who have experienced its presence in their herds. Those who have not seen the effect of its ravages should not only consider themselves fortunate, but should make every effort to avoid contact with the disease by acquiring as much knowledge about it as is now possible.

The history of the disease in cattle and its relative economic importance to the live stock industry has been related so many times that it would be placing a burden upon the reader to again discuss these two aspects of the disease.

It is the desire of the writer to convey to the breeder of livestock new light which has been thrown on the disease and its various manifestations by recent investigations, and also to correct many erroneous ideas about the disease now prevalent, the origin of which the investigators are partly responsible for.

Mode of Infection

It has been definitely established that the causative germ of the disease, in the largest percentage of cases gains entrance to the body of the susceptible animal of breeding age, pregnant or non-pregnant, by way of the digestive tract through the ingestion of infective material such as the discharge from an aborting animal or an infected animal at the time of calving, aborted feti or fetal membranes, or infective milk and possibly infective urine.

Investigations at the California Station show that the first point at which the germ gains access to the tissues of the body is in the region of the pharynx and larynx. The route which the germ takes from this point to the seats where it induces measurable damages, that is, in the udder and pregnant uterus, is not known. There is evidence that the germ may first invade the udder whether it be functioning or not. Again, it has been found to invade the pregnant uterus first.

The status of the new born calf in the abortion disease is a peculiar one. If the germ invades the pregnant uterus, but fails to produce tissue changes extensive enough to interfere with the normal delivery of the calf, there is a possibility that the calf is harboring the abortion

germ either in the lungs or alimentary tract, or in both. Some have observed that calves from infected cows are more predisposed to pneumonia and scours than calves from non-infected cows.

The germ may also gain entrance to the alimentary tract of the calf in very large numbers through the ingestion of infective milk and pass out in the feces.

Investigations at the California Station show that the germ is retained in the body of the calf only a short time after the ingestion of the infective material ceases. The evidence is, therefore, quite conclusive that such calves may be raised to maturity without showing evidence of the disease until re-exposed. If they are exposed to a sufficient amount of infective material at about the age of ten months or thereafter, it is quite likely that the abortion germ will establish itself in their bodies. On breeding (many such animals do not conceive readily) premature expulsion of the fetus usually follows at some period of the gestation.

The length of time between the exposure to the disease and the act of abortion cannot be foretold. Investigations, however, show that from two to four months may intervene between exposure by way of the mouth and expulsion of the fetus. The time is shortened somewhat by more drastic methods of exposure, such as intravenous inoculation.

When a pregnant or non-pregnant animal is exposed naturally to the germ, one of three courses may ensue as respects the disease proper. First, the natural immunity of the animal may be sufficient to prevent the establishment of the germ in the body. Second, the germ may establish itself in the body usually the udder, producing no disease of the fetal membranes, or to such a slight extent as not to interfere with the normal period of gestation and delivery of a normal calf. Such animals as a rule retain the infection in the udder for long periods and seldom abort. Third, the germ may gain entrance to the pregnant uterus as well as the udder and produce changes in the fetal mebranes of such a character that the normal nourishment of the fetus is interfered with. This condition results in setting up certain processes which cause the fetus to be expelled prematurely or at full time, but in such a badly diseased state that it lives only a few hours or days. The fetal membranes may or may not be retained in either case. The udder may be inflamed and the character of the colostrum or milk gargety.

The possibility of an animal aborting a second time, on subsequent breeding, is uncertain. It is known, however, that in herds where the disease is prevalent a large percentage of animals do not abort a second time. Such animals, as a rule, harbor the abortion germ in their bodies (the udder). They are termed "carriers" or spreaders of the disease.

The failure of many infected animals to abort or to abort more than once might be explained on the basis of what is known as an "organ immunity." That is to say, there is developed on the part of the tissue cells of the uterus a marked resistance to an invasion from the abortion germ. It either fails to gain a foothold in the pregnant uterus altogether or its progress is checked to such a degree that the nutrition of the fetus is not greatly disturbed.

The value to the breeder of infected animals that do not abort will depend upon whether they are pure bred or grades, and upon their ability to produce a sufficient amount of milk to more than pay for their keeping in spite of the constant danger of spreading the disease. It is a well known fact that the infection in the udder interferes with the normal functioning of part of the milk producing tissue to such an extent in some cases that the animal fails to pay for her board. Such animals are more of a liability than an asset.

The milk from infected udders in most cases appears normal to the eye, but on microscopic examination will show an enormous tissue cell content and on bacteriological examination show the presence of the infective germ, (*Bact. abortus*), in numbers varying from 100 to 10,000 per cubic centimeter of whole milk.

As regards the spread of the disease from infected udder to non-infected udder by the hands of the milker or milking machine, no one has yet demonstrated that this occurs, but on the other hand the possibility of doing so should not be over-looked.

Although the part played by the bull in the spread of the abortion disease has not been definitely settled, one should, nevertheless, guard against the bull from becoming infected through associating with infected females or serving them soon after aborting. Then too, the possibility of a bull with infected reproductive organs spreading the disease either through contact with susceptible animals or service should be guarded against. There is very good circumstantial evidence on record in which infected bulls have been incriminated as being the actual source from whence the infection was contracted by susceptible animals.

Diagnosis

The serological laboratory tests such as the agglutination test for the determination of infected animals is now universally accepted and considered as being as highly accurate and specific as any test used in the diagnosis of infectious diseases of man or animals. The present laboratory test is not 100 per cent perfect nor is any other diagnostic test for that matter. On the other hand if one disregards it altogether in an attempt to control the abortion disease one will soon find that the task to be a hopeless one.

The duration of time between the initial infection and the time when examination of the blood serum by means of laboratory tests shows positive evidence of the disease is very much of a variable. There have been recorded cases where the blood, by laboratory tests, showed evidence of the disease seven days after exposure and there are other cases which failed to show evidence of disease until four months after exposure.

It has been said many times that no one can determine whether an animal giving a positive reaction to the blood test will abort. This statement is in general still true. But in applying it to heifers that become infected in their first pregnancy, one may with confidence say that they will abort or deliver a premature calf in almost every case.

Another interesting occurrence in this connection is the occasional failure of the blood test to show evidence of the disease until the

day the abortion has taken place or a few days later. Many theoretical explanations have been offered to account for negative blood test findings in the presence of the disease, but the actual cause of the discrepancy is yet to be learned. Herein lies the chief weakness of the test and accounts for its failure to reach a stage of 100 per cent perfection.

When an animal aborts and the blood test repeatedly fails to show a positive reaction, one must remember that all abortions are not due to the Bang germ. In such cases it is very likely that another type of microorganism is the cause.

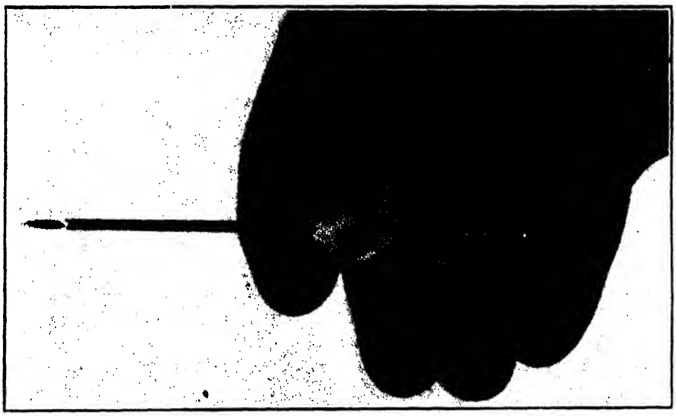
The Collection of Blood Samples

The materials needed for collecting blood samples for the laboratory agglutination test are: 1/3 ounce glass vials; gum labels; No. 14 or 16 gauge, three inch hypodermic needles; a disinfectant solution; and a rope halter or nose leader.

If the vials have not come from a laboratory where they have been properly prepared, they should be thoroughly cleansed, dried, have the corks placed in them and be sterilized by heating in an ordinary baking oven, not too hot, for one-half hour. The gum labels are now placed on the vials so that when the blood samples are taken they may be marked for identification.

Before procuring the sample of blood the animal should be effectively restrained in the stanchion or to a post as shown in Fig. I. If the operator is right handed the head should be drawn to the left, otherwise to the right.

The jugular vein, located in the jugular furrow, is dilated by firm pressure of the thumb of the left hand. The needle, previously rinsed with the disinfectant solution is grasped with the fingers of the right hand as shown in Fig. II and the point, with bevel upward inserted with a quick thrust perpendicular to the neck through the skin over the dilated vein about two or three inches above the position of the thumb. If the initial thrust has enough force behind it the needle will pass on into the vein and the blood will flow immediately from the free end, otherwise additional force will be needed to push the needle on into the vein. The vein should be kept dilated until the sample is collected. When the vial is about one-half full the needle should be withdrawn and washed out immediately or placed in a pan or jar of the solution of the disinfectant.



The vial containing the sample should be placed in a slanting position at an angle of about 20 degrees for at least one-half hour or until the blood has clotted. Although a separate needle for each animal is not absolutely needed, it is good practice. In all cases the needles should be thoroughly cleansed before they are used on another animal.

For the application of the test, blood samples should be sent by special delivery to the State Department of Agriculture in care of this laboratory. The name of the owner of the animals should accompany each group of samples.

Interpretation of the Test

In the performing of the test in this laboratory five dilutions of blood serum are used, mainly for determining the degree of infection. The dilutions used are 1-25; 1-50; 1-100; 1-200; and 1-500. The degree of reaction, as a rule indicates whether the animal is suspicious or infected with the abortion germ.

If a complete reaction is obtained in a 1-25 dilution only, this is evidence that the animal has or has had the abortion germ in her body. Whether the germ has established itself in the body one can-

not determine until a subsequent blood test is made in from 60 to 90 days. If the degree of reaction has not increased it is very probable that the germ failed to establish itself in the body. There are, of course, exceptions to this rule.

In attempting to control the disease in a herd by segregation methods it is far safer to separate such an animal along with those showing a more pronounced degree of reaction rather than leave her with those showing no evidence of a reaction to the blood test. If the blood of an animal should show a complete reaction in a dilution up to 1-50 or higher, she should be considered as being infected with the abortion germ. There are, of course, exceptions to this consideration.

This question has often been asked, will a reacting animal ever become a negative reactor thus indicating that she has completely recovered from the disease? In our experience less than one per cent of animals whose blood reacts in a dilution of 1-200 or higher become negative reactors. This would indicate that very few animals, once the germ is established in their bodies, become free from it.

Control Measures

At the present time the control of the disease is pretty well understood. The application of measures that are known to be effective will depend largely upon the facilities at the disposal of the breeder on his farm. At the present time there are three possible means that may be applied in controlling the disease. First, given an abortion free herd, one should use every possible precaution to keep it out. This may be effected by raising all breeding stock or when purchasing additional stock to do so only on the basis of the blood test, and by keeping suspiciously diseased animals off the farm. In other words, if others are using your herd sire be certain that animals brought to the premises are free from the disease. The other two courses of control apply if the disease is already in the herd. The first of these methods is absolute segregation of the infected stock from the non-infected, the other is the disposal of infected stock either by slaughter or to infected herds.

The segregation plan is not an economic one for the majority of breeders, for it necessitates two separate barns and two separate pastures. The second plan may be economically employed if there are only a few animals of the herd infected.

We believe that the small herd owner is the one who is most affected by this disease and will continue to be so. Extreme uneconomic measures are going to tax his resources severely so much so that it will be utterly impossible for him to continue in the dairy business. It has been our object to seek means through research whereby the disease may be suppressed in a herd through protection given to susceptible animals. The disease will be gradually eliminated from such herds through the disposal of the infected animals as they become unprofitable. Our plan which involves the use of protective vaccination has been in the process of development for the past six years. The results are highly encouraging in both experimental and field herds. Just when it will be determined that this agent has survived the experimental stage which implies that it is ready for general use is not known.

In the meantime, herd owners should not desert well known sanitary measures as a means of preventing the spread of the disease already present in the herd or by keeping it out of an uninfected herd. In the case of those who are contemplating the building up of dairy herds, an effort should be made to procure only animals that are free from the disease. When this is accomplished one should never cease to bend every effort in the direction of keeping the herd free. In doing so they should be guarded from contact with infected animals, from drainage water coming from adjoining pastures where infected animals are permitted access, from the promiscuous use of the herd sire on animals outside the herd.

For those who already have infected animals in their herds, the only reliable measures for eliminating the disease is the disposal of the infected ones or complete segregation. In carrying out either procedure, the negative ones (those free from the disease) should be tested every 30 days for the first six months in order to detect the presence of any recently infected. The first blood test would fail to detect these. After the first six months period, they should be tested twice yearly at intervals of six months.

The effort to keep a herd free from the abortion disease or to free it from the disease will require much patience and persistent effort and in many cases will prove very costly, in fact too costly for the small herd owner. All efforts in the end will be rewarded by increased milk production and breeding efficiency for the herd.

It might be stated in conclusion that, when breeding trouble or abortions occur in a herd and the animals fail to react to the laboratory serum test, one should not overlook or completely disregard the trouble by placing the blame on the feed or lack of minerals. The cause of breeding troubles in animals by infectious agents other than the Bang germ must not be disregarded. Very often they are responsible for serious losses in a herd. In all cases of abortion or breeding troubles the breeder should look to the veterinarian for assistance and advice for without him and his knowledge, the suppression of breeding troubles in livestock is impossible.

Pathogenicity of the Abortion Germ for Humans

There has appeared on the horizon during the past two years, the possibility that the germ which is responsible for a large percentage of abortions in cattle is also pathogenic for humans, the characteristic symptoms being not abortion, but an intermittent or wave-like fever similar in many respects to typhoid or malarial fever. There have been nearly 50 cases reported in the United States, 14 of which occurred in Michigan, during the past two years.

The source of the infection in most of the cases has been traced to the ingestion of infective raw milk coming from herds in which abortions have occurred. The germ isolated from the affected humans is indistinguishable from the one causing abortion in cattle or found in infective raw milk. The full significance of the disease with reference to its occurrence in cattle cannot be stated at this time.

IS EIGHT POUNDS OF ALFALFA SEED TO THE ACRE SUFFICIENT?

Experiments Show Crops Satisfactory in Yield and Quality Produced By Light Seedings

C. R. MEGEE, FARM CROPS SECTION

The amount of alfalfa seed that should be sown on an acre of land varies greatly and depends upon the viability and purity of the seed, the preparation of the seed bed, and the equipment available for making the seeding. Only a few years ago, seedings as high as 30 pounds per acre were commonly applied. Today one frequently hears of instances where 8 pounds of seed to the acre gave an excellent stand and occasionally 6 pounds proves sufficient.

To quite an extent, the change has been brought about by a marked improvement in the quality of the seed, especially in its percentage of germination and winter hardiness of variety. It is far better to seed 8 or even 6 pounds of clean, winter hardy seed of high germination than to sow 15 or 20 pounds of inferior seed of low germination and of a variety lacking in winter hardiness. The preparation of the seed bed is also of great importance. A well firmed and compacted seed bed brings the small, more or less water-proof alfalfa seed in contact with moisture that is necessary for germination. The loose seed bed frequently causes failure due to the inability of the alfalfa seed to take up moisture or due to the seed being covered too deeply.

In 1922, a series of 28 alfalfa plats was seeded at the Michigan State College Agricultural Experiment Station at rates ranging from 3 pounds to 24 pounds per acre, as follows: 3-6-9-12-15-18-21-24. The drill was set to sow the above amounts but the actual amounts sown were as follows: 4.7-8.1-10.9-13.6-16.0-18.3-21.0-24.0. The soil was of a light sandy type, well compacted with the cultipacker. The seed was sown with the seeder attachment of an ordinary grain drill, the tubes from the seeder attachment were set so that the seed was distributed in a broadcast manner partly in front of and partly on to the discs, which covered the seed at a depth ranging from ½ to ¾ of an inch. High quality Grimm seed was used. That the rate of seeding did not influence the yield of hay secured is shown by the following data:

Rate of Seeding Alfalfa -vs- Yield of Hay Secured

(Well firmed seed bed - High quality seed)

Pounds of seed sown to the acre		Tons of air dry hay per acre. (12% moisture)					
Drill set	Actually sown	1923	1924	1925	1926	Total	Average
3	4.7	2.54	5.64	2.90	3.10	14.18	3.54
6	8.1	2.72	5.82	3.03	3.34	14.91	3.72
9	10.9	2.59	5.72	3.18	3.30	14.79	3.69
12	13.6	2.58	6.00	3.14	3.23	14.95	3.74
15	16.0	2.69	5.77	3.31	3.32	15.09	3.77
18	18.3	2.67	5.83	3.13	3.40	15.03	3.75
21	21.0	2.59	5.81	3.15	3.29	14.84	3.71
24	24.0	2.62	5.93	3.14	3.40	15.09	3.77

The above results indicate that when winter hardy seed of a high percentage germination is sown on a well firmed seed bed with a good drill the rate or amount of seed sown within certain limits (4.7 pounds to 24 pounds) does not influence the amount of hay secured per acre during the first four years. The differences in yield of the above rates of seeding are so small as to be of no significance. This is shown by the following data:

	Tons
Highest yield	3.77 ± 0.182
Lowest yield	3.54 ± 0.170
Difference	0.23 ± 0.25

The probable error is greater than the difference which indicates that the rate of seeding did not influence the yield of hay.

The quality of commercial seed varies to some extent from season to season as also does the equipment available on many farms for making the seedings. In order to meet these irregularities it seems advisable to use from 8 to 10 pounds of high quality seed of Hardigan, Grimm, Ontario Variegated, or other hardy varieties per acre under ordinary conditions.

ATYPICAL SYMPTOMS AND LESIONS OCCURING IN CHICKS HARBORING BACT. PULLORUM

Unusual Symptoms of Disease Found in State Believed To Be Caused By White Diarrhea

BY H. J. STAFSETH AND E. P. JOHNSON, BACTERIOLOGICAL SECTION

Within the past few months we have had occasion to examine chicks from various parts of Michigan that have manifested symptoms and

lesions somewhat different from anything encountered before. We first noticed the condition, to be described, in chicks about two weeks of age that had died and were sent to us by the hatcherymen for examination. Since that time chicks with similar symptoms and lesions, coming from different parent stock, fed on different feeds and kept under different conditions have been sent to us for examination. The symptoms as described by poultrymen and as they have been observed by us are briefly as follows:

Symptoms

The owners invariably report that the affected chicks develop an abnormal thirst, some, to the extent that they remain at the water fountains continuously. They also report and we have noticed in a few cases, that a watery, brownish colored diarrhea occurs shortly after these symptoms begin, even to the extent that it is impossible to keep the floor of the brooder house dry. The chicks usually swell up, become very large and owners speak of them as being bloated or puffed up. In all cases brought to our attention and in those observed these symptoms have occurred at the age of six to fifteen days. Usually all chicks showing these symptoms die after from four to six days of illness. In a number of cases the feed has been changed at about this time and the fact that losses have stopped at about the time the feed was changed has led some poultrymen to think that the feed was at fault.

Feed Blamed For Ailment

It so happened that a large number of flock owners that have experienced this trouble were using one particular brand of feed which made it reasonable for them to at least be suspicious as to the wholesomeness of this feed. However, in the course of our investigations we have found cases where entirely different feeds were used and several flock owners using the suspected feed report no trouble but on the other hand report excellent results. Because of the abnormal thirst, mentioned above, flock owners thought that the feed must contain too large an amount of salt and requested that the feed be analyzed chemically. Several samples of feed taken from places where this trouble existed were brought to the experiment station chemist to find out more about the salt content. He found that the various samples of feed contained from 1½ to 2 per cent salt. This analysis would show not only added salt but also the salt content of meat and milk in the feed or the total amount of salt present. Judging from experiments carried out by *Mitchell, Card, and Carmen at the University of Illinois this amount of salt is not harmful to chicks. The chemist further stated that he found no ingredients that, in his opinion, should be harmful to chicks. To satisfy ourselves we have fed considerable amounts of the feed to experimental chicks and have found no detrimental effects after two weeks of feeding.

Autopsy and Bacteriologial Findings

A post mortem examination of all affected chicks revealed a typical picture of dropsy; the subcutaneous tissues were filled and distended

with a watery, edematous fluid, often being gelatinous in consistency; the thoracic and abdominal cavities were usually filled with the same fluid. The heart was invariably very thin-walled and flabby, frequently the liver was light yellow or ochre colored and very friable; and usually considerable unabsorbed yolk, that was either of a liquid or cheesy consistency, was found.

On making a bacteriological examination of the tissues we invariably found **Bacterium pullorum.** We have also encountered an organism that is a gas producer fermenting glucose, lactose, maltose, and mannite; but on feeding this and injecting it into susceptible chicks we have been unable to produce neither the symptoms nor the lesions described above. Thus it seems probable that these symptoms and lesions are different manifestations of bacillary white diarrhea infection that may be brought about by some contributory influence that has not yet been discovered.

While we do not pretend to have solved this problem, it was thought advisable to call the attention of other workers to this condition as it may be present in other localities without being recognized.

*The toxicity of salt for chickens—by H. H. Mitchell, L. E. Card, G. G. Carmen, Illinois Sta. Bulletin, 279 (1926) p. 133-156.

MUTILATION OF TWIGS AND CANES, DUE TO THE DEPOSITION OF EGGS BY THREE COMMON INSECTS

Concentration of These Insects in Certain Areas Injures New Stock

R. H. PETTIT, ENTOMOLOGICAL SECTION

At pruning time, the Department of Entomology is sure to receive each year samples of twigs and canes that bear either fresh mutilations or the scars produced by mutilations of previous seasons. Three types of such lesions predominate.

THE TREE-CRICKET

The greatest number of scars are produced by tree-crickets when they lay their eggs in new growths of raspberry, blackberry, grape, peach, or less often, in other host-plants which have large pith cavities and relatively thin shells. The eggs are laid typically in a long row, each egg being placed in a hole pierced through the shell of the cane or twig into the pith. Such eggs hatch out into tree-crickets in the spring.

Figure 1 shows the appearance of a raspberry cane in which the eggs are shown in place. The mutilation, which consists of a row of deep performations pierced through the shell of the cane, often is the

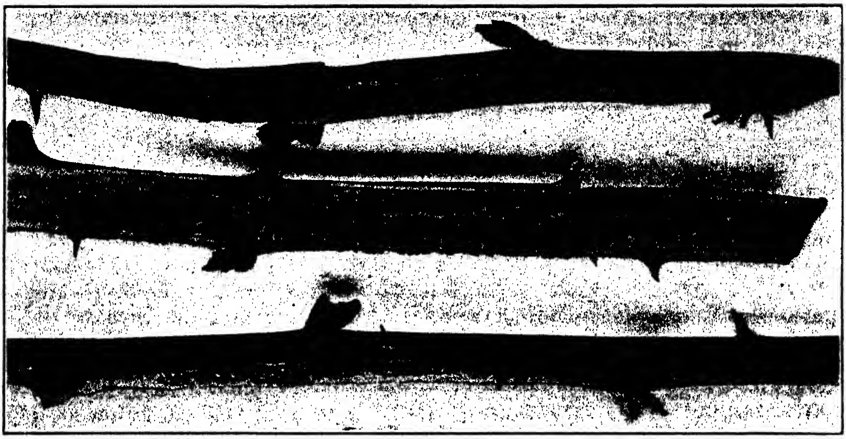


Fig. 1.—Eggs of Tree-cricket in berry cane. Also canes cracked as result of punctures.

cause of a cracking of the canes, and so great is the resulting mechanical injury that the cane seldom is capable of producing fruit of good quality. Such split or mutilated sections of cane can, and should, be cut out and burned.

There is, however, some compensation for the loss of part or all of the cane, since the adult tree-crickets are reported to feed largely on plant-lice so that, on the whole, the tree-cricket may not be an agent of unmixed evil. The good that it does may requite the grower, in part or altogether, for the injury which results from the deposition of its eggs.

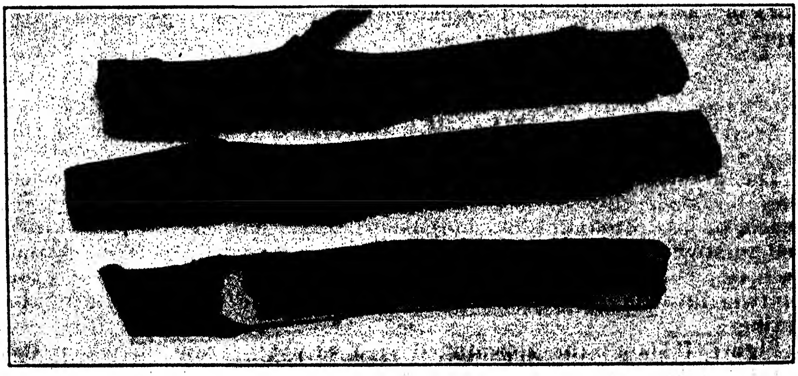


Fig. 2.—Scars from old work of Tree-cricket on Sumach.

THE BUFFALO TREE-HOPPER

Apple twigs are often deformed and sometimes killed by the deposition of eggs by the buffalo tree-hopper, *Ceresa bubalis,* and less often by an allied tree-hopper known as *Stictocephalus inermis.* The first named bug lays its eggs in paired slits slightly curved so that they suggest a pair of parentheses. In each of these parenthetical slits, five or six or more long slender eggs are thrust so that they are embedded in the twig. These groups of eggs are often crowded so closely that the vigor of the twig is seriously impaired. Small stuff just set out may suffer the loss of so many of its twigs that the young trees may be killed outright or, if not killed, the branches lost may result in a seriously deformed tree which will hardly be worth raising. Older trees seldom suffer permanent injury, since wounds of this type usually heal; and, while the resulting scars may mystify the owner, the tree will continue to thrive.

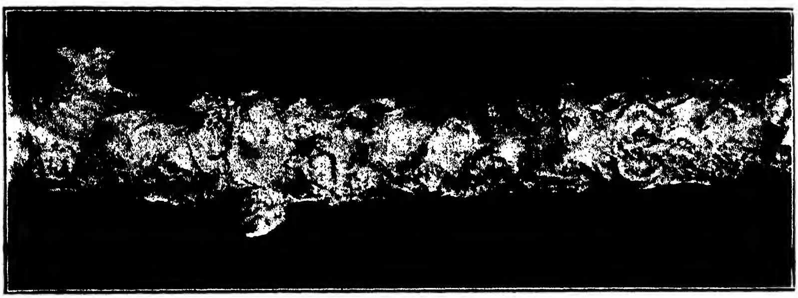


Fig. 3.—Scars made by Buffalo Tree-hopper.

Injury of this sort almost always occurs in locations where there is fresh succulent plant food for the adults in the fall. The eggs are laid in the late summer and fall and the adult tree-hoppers which feed on the sap of succulent herbaceous plants are attracted to and congregate in localities where they find both succulent plants and tender new twigs of trees and shrubs. Not only fruit-trees but a variety of others are suitable to receive eggs.

As previously stated, well established and sizable trees seldom suffer permanent injury; but young nursery stock that is set out in fields of alfalfa or other succulent growth are necessarily required to undergo the extra hazard of becoming the repositories of sufficient eggs of the buffalo tree-hopper to cause the death of certain branches and twigs which in the ordinary course of events would be expected to form the lattice limbs of the future tree. Naturally, the form of the future tree must be determined by the development of such twigs as are left alive after part of the twigs have been killed.

Fig. 4.—Eggs of *Stictocephalus inermis* embedded in apple twig. Enlarged about 5 X.

STICTOCEPHALUS INERMIS

Less frequently met with are the scars of this latter insect. Figure 4 shows the characteristic lesions resulting from the laying of the eggs which are placed in paired slits at a greater angle to the perpendicular than those of the true buffalo leaf-hopper. The work of the Stictocephalus is often accompanied by a cracking and curling back of the bark. The comments made about the buffalo tree-hopper regarding the selection of a suitable place for congregating in the fall and laying its eggs seem to apply with equal force to this latter insect.

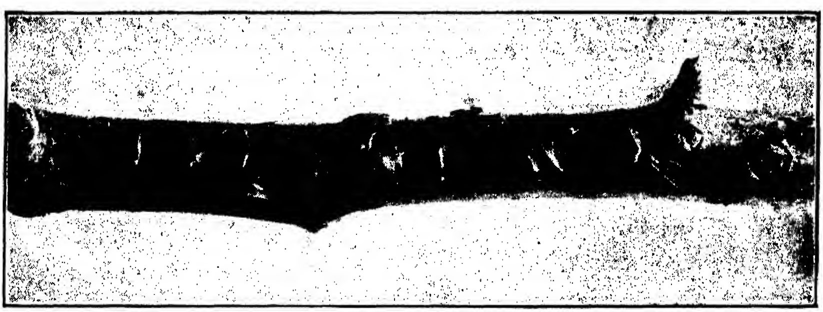


Fig. 5.—Scars on apple twig produced by *Stictocephalus inermis*. Enlarged about 2 X.

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Romaine, J. D., B. S.	Asst. in Soils
Schlubatis, G., M. S.	Asst. in Soils
Musselman, Marion G., B. S.	Asst. in Chem.
Burt, Kenneth, B. S.	Asst. in Chem.
Bandemer, Selma L., M. S.	Asst. in Chem.
Carpenter, Miriam C., M. S.	Asst. in Bot.
Clements, H. F., M. S.	Asst. in Botany
Johnson, E. P., D. V. M.	Asst. in Bact.
Sholl, L. B., [illegible] S., D. V. M.	Asst. in Animal Pathology
Putnam, G. W., M. S.	Director Upper Peninsula Experiment Station, Chatham
Wells, H. M., B. S.	Supt. Graham Horticultural Experiment Station, Grand Rapids.
Johnston, S., B. S.	Supt. South Haven Horticultural Experiment Station, South Haven
Landon, L.	Librarian
Schepers, J.	Cashier
Campbell, M. W.	Bookkeeper
Bogue, M. V.	Bulletin Clerk

SUB-STATIONS

[illegible]hatham, Alger County, 780 acres deeded. G. W. Putnam, Director.
[illegible]aven, Van Buren County, 10 acres rented; 5 acres deeded. S. Johnston, Supt.
[illegible]Station, Kent Co., 50 acres donated by R. D. Graham; 50 acres purchased. H. M. Wells, Supt.
[illegible]Chippewa County, Forestry station, 577 acres deeded.
[illegible]onroe County, Corn Borer Station, 7½ acres rented.